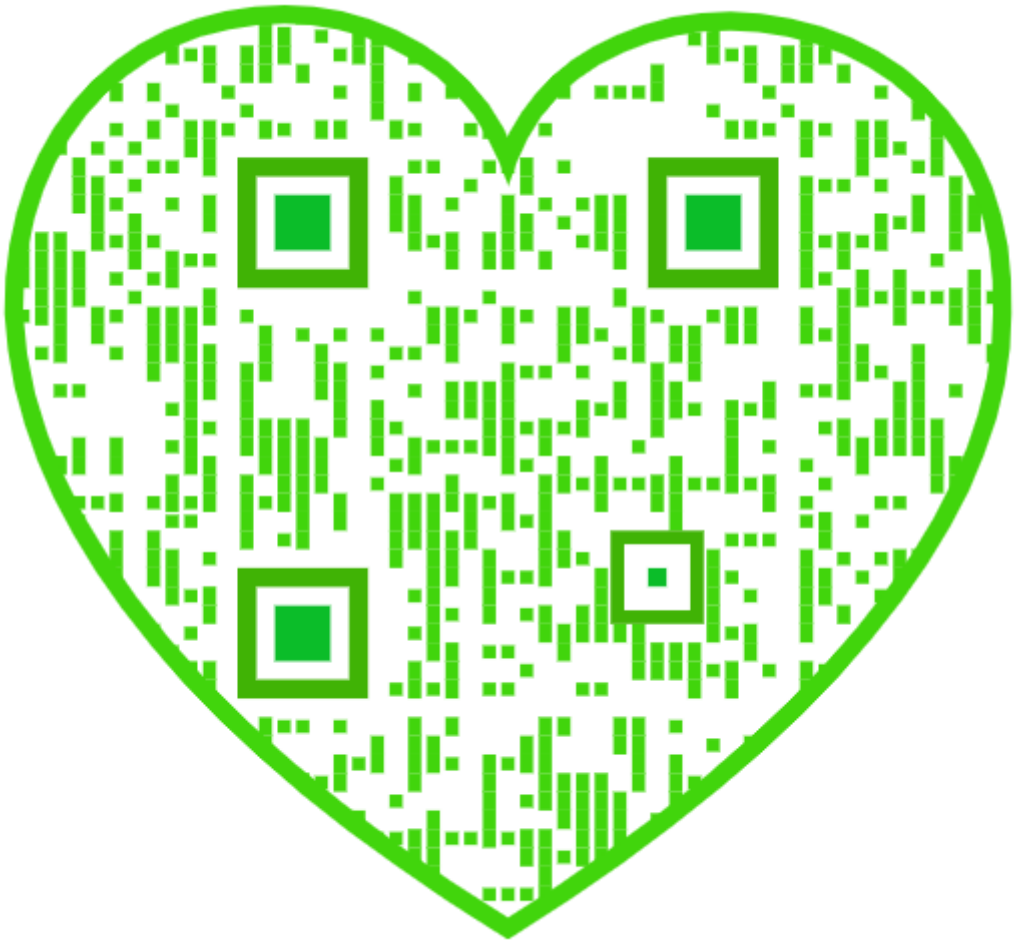

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SOME ECONOMIC GEOLOGY OF MONTANA

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FIGURES

Page.

Fig. 1—Seam No. 1, Red Lodge 3
Fig. 2—Seam No. 1½, Red Lodge 4
Fig. 3—Seam No. 2, Red Lodge 4
Fig. 4—Seam No. 4, Red Lodge 5
Fig. 5—Seam No. 5, Red Lodge 6
Fig. 6—Seam No. 6, Red Lodge 7
Fig. 7—Seam No. 2, Bear Creek 8
Fig. 8—Seam No. 3, Bear Creek 8
Fig. 9—Seam No. 4, Bear Creek 9
Fig. 10—Seam No. 5, Bear Creek 9
Fig. 11—Cross Section Joliet Coal & Fuel Co's. Seam 10
Fig. 12—Cross Section of Bridger Seam 10
Fig. 13—Cross Section of Seam at Gebo 11
Fig. 14—Cross Section of Mountainhouse Seam 11
Fig. 15—Cross Section of Aldridge Seam 13
Fig. 16—Cross Section of Seam at Storrs 15
Fig. 17—Cross Section of Seam near Darby 18
Fig. 18—Cross Section of Seam, Fergus County 19
Fig. 19—Cross Section of Seam, Fergus County 19
Fig. 20—Cross Section of Havre Seam 20

PLATES

PLATE I—New Tipple and Social Separator, Red Lodge 3
PLATE II—Old Tipple, Northwesern Improvement Co., Red Lodge. 6
PLATE III—Tipple, Electric Light Plant, and Reserve Coal, Bear Creek Coal Co. 8
PLATE IV—Montana Coal and Coke Co. Washer at Aldrich 12
PLATE V—Interior of Washer, Montana Coal and Coke Co., Aldrich, Park County 13
PLATE VI—Coke Ovens, Montana Coal and Coke Co., Electric 14
PLATE VII—Gypsum Mill, near Armington, Cascade County 32
PLATE VIII—Gypsum Outcrop near Armington, Cascade County 34
PLATE IX—Gypsum Mine near Bridger, Carbon County 35
PLATE X—Limestone Cliffs, Lombard, Broadwater County 39
PLATE XI—Limestone Outcrop, near Lewistown, Fergus County 40
PLATE XII—Lime Kiln, near Lewistown, Fergus County 40
PLATE XIII—Limestone Outcrop, near Red Lodge, Carbon County 41
PLATE XIV—Limestone Lodge, near Red Lodge, Carbon County 41
PLATE XV—Lime Kiln, near Red Lodge, Carbon County 42
PLATE XVI—Quarrying Friable Sandstone, Daily Spur, Beaverhead County 43
PLATE XVII—Reservoir Sandstone Quarry, near Dillon, Beaverhead County 43
PLATE XVIII—Sandstone Quarry, near Havre, Choteau County 44
PLATE XIX—Court House at Big Timber, Built from Local Sandstone 44
PLATE XX—Sandstone Quarry, near Lewistown, Fergus County 45
PLATE XXI—Church at Lewistown, Made of Sandstone 45
PLATE XXII—Sandstone Quarry, near Lewistown, Fergus County. 45
PLATE XXIII—Billings Public Library, Built of Billings and Columbus Sandstone 46
PLATE XXIV—Sandstone Quarry, Columbus, Yellowstone County 46
PLATE XXV—Yellowstone County Court House, Billings. Built of Columbus and Billings Sandstone 47
PLATE XXVI—Col. Chisholm's Onyx Quarry, near Manhattan, Gallatin County 47
PLATE XXVII—Granite Quarry, near Helena, Lewis and Clark County 48
PLATE XXVIII—Kain & Sons' Granite Quarry, near Helena, Lewis and Clark County 48
PLATE XXIX—Granite Quarry, Welch's Spur, Silverbow County 49
PLATE XXX—Granite Quarry, Welch's Spur, Silverbow County 49
PLATE XXXI—Granite Quarry, Elk Park, Silverbow County 49
PLATE XXXII—Granite Needles, Blodgett Canyon, Ravalli County 50
PLATE XXXIII—Granite Domes, Blodgett Canyon, Ravalli County 50
PLATE XXXIV—The Orve Evans Residence, Butte, Made from Dillon Quartzite 50
PLATE XXXV—Volcanic Ash Deposit, near Forsythe, Rosebud County 51
PLATE XXXVI—Volcanic Ash Quarry, Frying Pan Basin, Beaverhead County 51
PLATE XXXVII—The Hight Residence, Butte, Built from Dillon Volcanic Ash Rock 51
PLATE XXXVIII—Volcanic Ash Quarry, Frying Pan Basin, Beaverhead County 51

PLATE XXXIX—Phyllite Quarry, near Kalispell, Flathead County.. 52
PLATE XL—The Western Clay Manufacturing Co., Helena, Montana 52
PLATE XLI—Western Clay Manufacturing Co., Helena, Montana; Dry Building, Western Clay Manufacturing Co. 53
PLATE XLII—Western Clay Manufacturing Co., Helena, Montana.. 54
PLATE XLIII—Lower Yard, Butte, Montana..... 55
PLATE XLIV—Silica Brick Kiln, Butte, Montana; Sheds and Part of Continuous Kiln, Butte, Montana..... 56
PLATE XLV—Crucible Mould, Butte; Common Brick Moulds, Butte, Montana 57
PLATE XLVI—Clay Deposits, near Whitehall..... 57

Introduction.

This bulletin is intended to convey to the general reader an idea of the locality, uses, brief description and geology of some of the natural non-metallic economic deposits of Montana. From time to time articles, by the writer, have appeared in the mining and scientific magazines of the United States, and this is mainly a collection of these articles, often times revised and enlarged, into a compact and useful form.

Many books on Economic Geology, State reports, and reports of the United States Geological Survey, have been freely consulted and drawn from. The work in the main, however, is entirely new, and the result of the University Geological Expeditions conducted each summer by the writer.

Acknowledgments.

The writer of this bulletin is greatly indebted to United States Senator William A. Clark for his interest and help in this work; also to the Northern Pacific, Great Northern, Oregon Short Line and Montana Central Railroads for their assistance in transportation. Through the kindness of Senator Clark and the railroad companies operating in Montana, the writer has been able to pursue this kind of work in the State that otherwise would have been impossible.

Thanks are also due to "Brick," of Chicago, and the "Mining World," of Chicago, for several plates loaned by them.

The coal statistics were furnished by Mr. J. B. McDermott, State Coal Mine Inspector.

Coal and Lignite Deposits

Since the writer's bulletin on the "Montana Coal and Lignite Deposits" appeared in 1906, there has been considerable change in the coal and lignite industry of Montana. Many new operators are now in the field and all of the areas are better developed. Only a few of the many areas in the State will be discussed in this paper. During the past two years the United States Geological Survey, under the direction of Mr. C. A. Fisher, Mr. A. G. Leonard, Mr. N. H. Darton and the writer, has done considerable work in Montana on these deposits. For a more detailed report on the Bear Creek, Bridger, Plains Lignite and the Great Falls areas one should read the U. S. Geological Survey Bulletin No. 316, pp. 161 to 211 inclusive.

CARBON COUNTY

There are five fairly large producing areas or localities in this county. They belong in reality to two different fields—the Northwestern Improvement Company, at Red Lodge; and the mines at the Bear Creek area belonging to the same field. The mines at Joliet, Bridger and Gebo, belong to another distinct field, known locally as the Bridger field.

Northwestern Improvement Co., of Red Lodge.

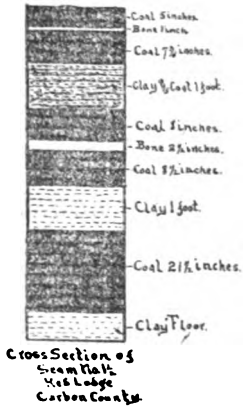
This is by far the largest coal operating plant in Montana. It is a part of the Northern Pacific Railway Company, and C. C. Anderson is general superintendent of this plant, and of all of the Northern Pacific's coal holdings in the State. These mines were first opened in 1887 and in 1903 had a total production of over 541,000 short tons. There are eight seams of coal found in this field with an aggregate thickness of over 60 feet of coal. Not all of these seams, however, are at present being worked. No. 1 has

Fig. 1.

Cross Section of Seam No. 1 Red Lodge Carbon County.

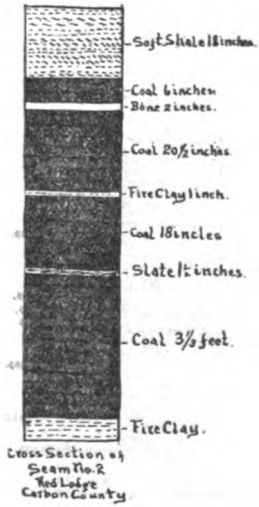
a thickness of nearly 6 feet, including a few streaks of bone. No. 1 1-2 is about 6 feet thick, with four small partings of clay and

Fig. 2.

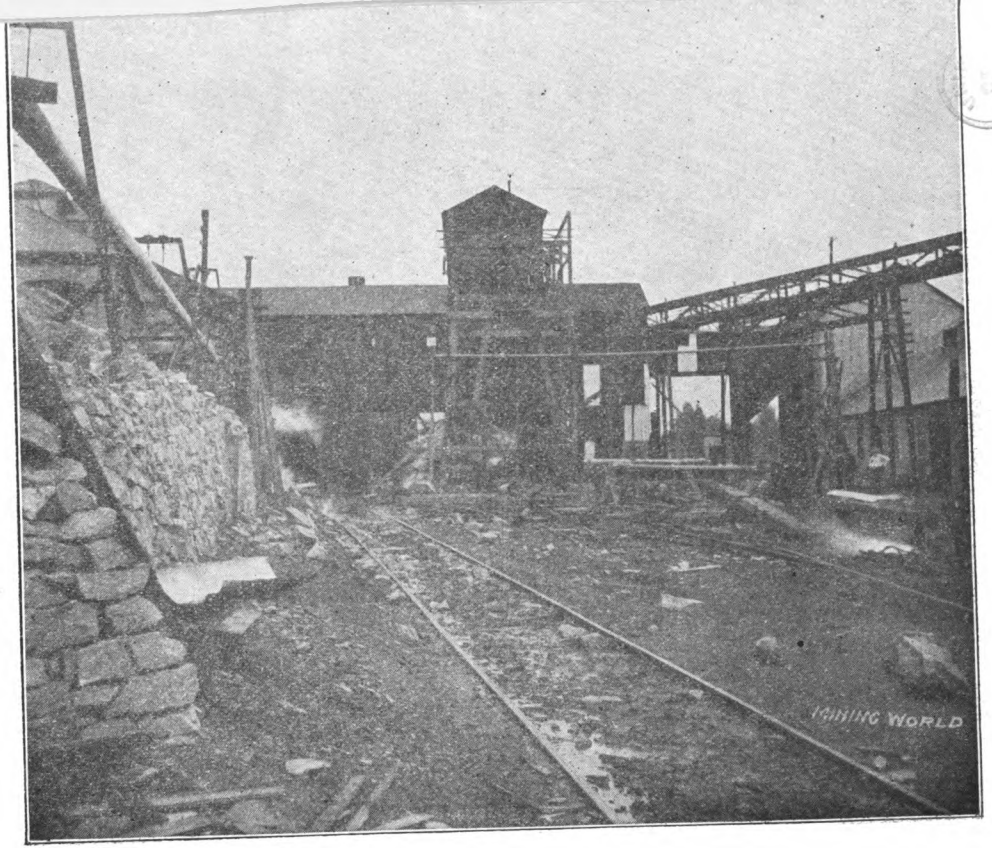


bone. No. 2 is over 7 feet thick, with a few bands of shale and

Fig. 3.

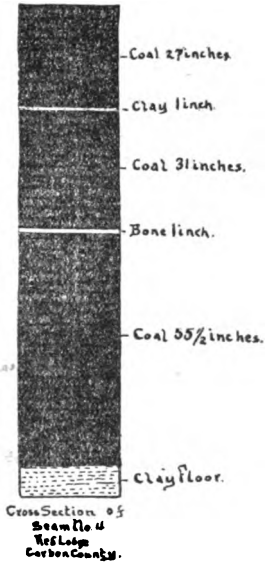


No. 3 is between 12 to 14 feet thick, but owning to the of streaks of slate and shale it is not worked. No. 4 is



New Tipple and Spiral Separator, Red Lodge.

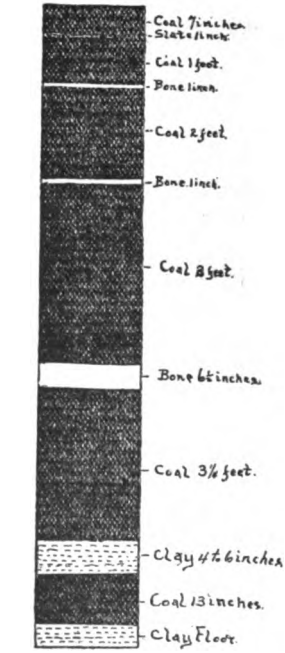
Fig. 4.



about 9 1-2 feet thick, with but two small partings. No. 5 is between 12 and 14 feet thick, with many partings. No. 6 is some over 5 feet thick, with but a small streak of bone running through the center.

This property is worked from two main "entry ways" or "slopes," No. 2 and No. 4 sloeps. The former is in about 1,800 on the dip, while the latter is in over 2,600. Seams Nos. 1, 1 1-2, 2, 4, 5 and 6, are the only ones now being worked. No. 4 is the best worked seam in the mine. This seam has six east and four west levels. The third, fourth and fifth levels east and the second level west are the only levels now being worked on seam No. 4. The sixth level east of seam No. 4 is under water. The fifth level east on the No. 4 seam is where the greatest development work of the mine has been done. This level has 110 rooms, and from the main slope or tunnel to the face of the fifth level east is more than 8,000 feet. The method of working all of the seams and levels is by room and pillar. The distance of the rooms from center to center is 70 feet. The general distance between levels is 550 feet. A good substantial pillar is left between rooms, and after the rooms are worked out the pulling of the pillars is undertaken. This latter is a thing that has not appeared to have been generally done in the Red Lodge mines, hence not a large percent of the coal has been taken from each level. During the past year and for the future this work will be done, and at least a half more coal from each level will be mined.

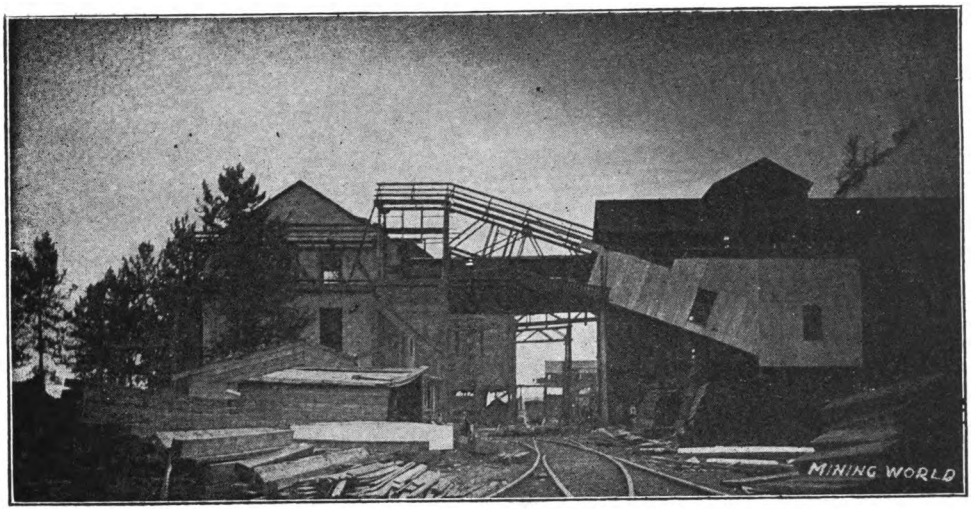
Fig. 5.



Cross Section of Seam No. 6 Nesbitt Carbon County

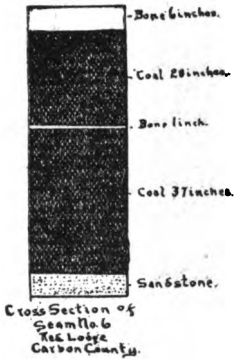
The mine haulage is done by means of cables on the main slope and to the tipples; electric motors in many of the levels; and gravity from the upper rooms to the levels. In some of the shorter and less important levels mules are used to pull the cars to the main slope. From the rooms to the levels a car loaded with coal gradually goes down the dip, about 18 degrees, and by means of a double track an empty car is pulled up to the face of the room. Parts of the mine are lighted by means of electricity, while in other parts only the miner's lamp is used. No safety lamps are used by the miners at this place, as the explosive gas is scarcely known. This mine as a whole is well ventilated and on the upper levels water is no great hindrance.

PLATE II.



Old Tipple, Northwestern Improvement Co., Red Lodge.

Fig. 6.



The interior conditions, outside of the disaster of June 7, 1906, are generally first-class, and the accidents are not large.

No machine mining is done at this mine.

The outside plant of this company is completely modern in every way. There are two tipples; an electric light plant, generating both alternating and direct currents, recently enlarged; a 600-ton Luhrig washer, completed early in 1903; steam and electric fans; revolving dump and shaking screens, picking tables, gravity box car loader, just finished; 8 spiral separators of the Pardee type, and many other newly installed and up-to-date improvements.

Bear Creek Area.

This field, lying wholly within Carbon Coutny, is the best recently developed field in Montana. It is really a part of the Rocky Ford field, having the same seams and same geological formation. The dip is slightly different from the Red Lodge beds, being about 4 degrees to the west. The field is now connected to the Northern Pacific Railroad by the Yellowstone Park Railroad, running from Bridger to the town of Bear Creek and to the various mines.

There are six distinct workable beds in this field, but Nos. 1, 5 and 6 are, as yet, worked but little. No. 2 bed shows great promise, and the Montana Coal and Iron Company has an excellent mine on this seam. Senator McCarthy is also developing a promising mine on the same bed. The cross-cut of this seam on the Montana Coal and Iron Company's property is about as follows:

Fig. 7.

This company is now working between 25 and 40 men, and has market for all the coal it can mine. The mine is in only about 300 feet, but the coal is a good domestic and steam coal, and in great demand.

Beds Nos. 2, 3 and 4 are also worked farther east by the Bear Creek Coal Co. This company has excellent equipment, and will soon be able to turn out a large daily tonnage. Nearly 10,000 acres of land are controlled by this company, and "its mines are in the N. E. 1-4, Sec. 6, T. 8 S., R. 21 E., about a mile west of the town of Bear Creek." The following is a cross-cut of seams Nos. 3 and 4:

Fig. 8.

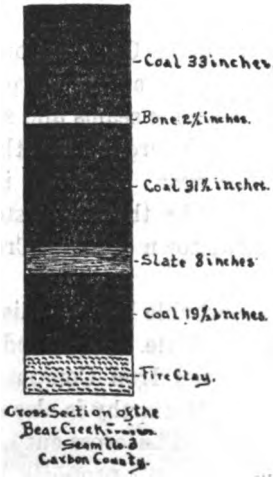
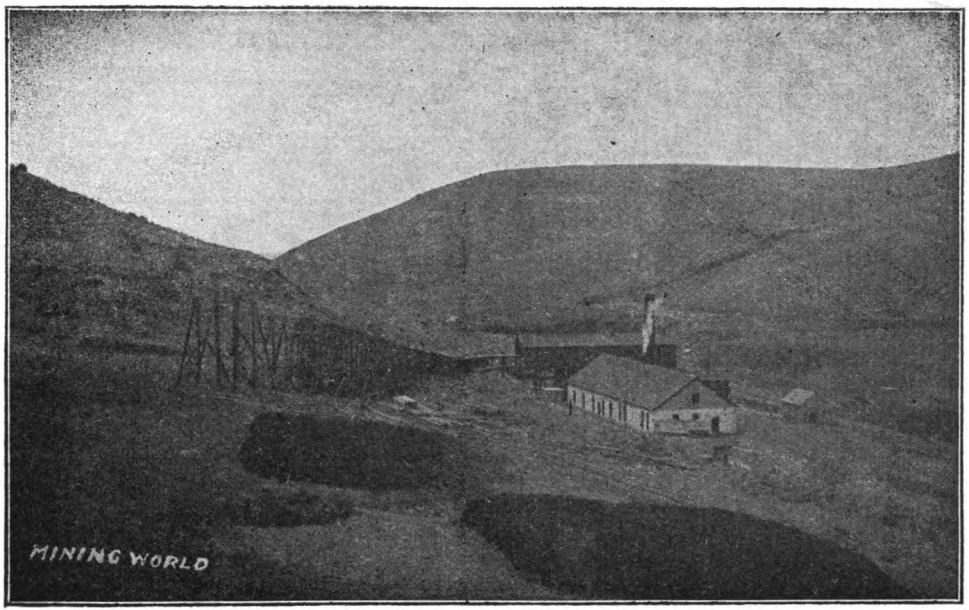


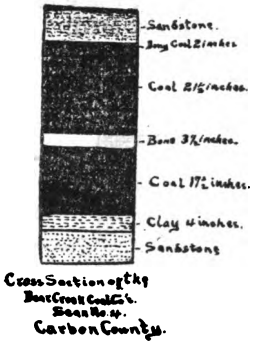
PLATE III.



Tipple, Electric Light Plant, and Reserve Coal, Bear Creek Coal Co.

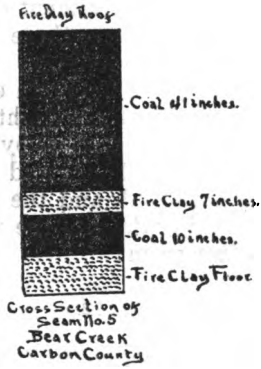
The company has done about 1,000 feet of tunneling on this seam.

Fig. 9.



Seam No. 4 is about 80 feet below seam No. 3. The mouth of the tunnel is nearly 500 feet south of the tunnel on No. 3, and is in about 200 feet.

Fig. 10.



The Northern Pacific Railroad Company and several other large companies own land in the Bear Creek field, and within a couple of years, at the present rate of progress, this will be one of the largest coal producing fields in the state.

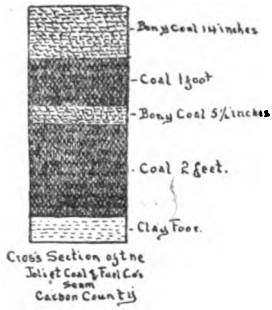
The Bridger Field

This field proper belongs to the Clark's Fork field, but as the workable coal pinches out north of Joliet, and the coal strata are probably not continuous, farther north, it will be treated as a separate field. It lies entirely within Carbon County.

The coal strata of the Bridger field can easily be traced from Joliet, Carbon County, to south of Bridger, a distance of about 25 miles. The chief producers of this field are the Bridger Coal and

Improvement Company, of Bridger; the Gebo Coal Company, of Gebo; the McCarthy mine, near Fromberg, and several mines near Joliet; probably the best near the latter place is the Joliet Coal and Fuel Company. Each of these mines are in active operation, with Bridger and Gebo in the lead.

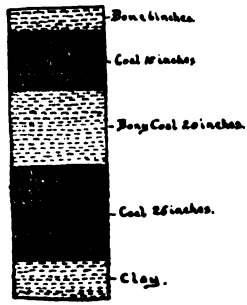
Fig. 11.



Cross Section of the Joliet Coal & Fuel Co's Seam Carbon County

The Bridger Coal and Improvement Company work their mine by the long wall method, and use three Link Belt Undercut electric machines for driving the entries. The seam has a dip of 6 degrees to the southwest, and the main entry or slope is in about 3,500 feet. The mine is partially lighted by electricity, and is well ventilated. The haulage is done by cable, on the main entry, and three stationary electric hoists and mules to the main entry. About 120 men are employed, and the output is about 140 tons per day, with 240 working days to the year. The following is a cross-cut of the Bridger seam:

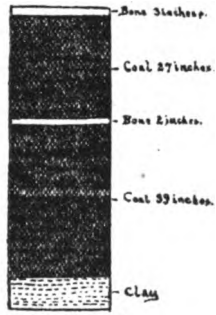
Fig. 12.



Cross Section of the Bridger Coal & Improvement Co Mine Carbon County

The Gebo Coal Company, working on the same seam as at Bridger, with a somewhat cleaner bed, has modern improvements in every way and produces about 100 tons per day. The company employs about 45 men and use electric mining machines. The mine is in on the dip about 900 feet. The following cross-cut will show the difference between the Gebo and Bridger mines:

Fig. 13.



Cross Section of the Gebo Coal Company's Mine Carbon County.

The Trail Creek Field

The Trail Creek field is a small isolated area about 9 miles south of Mountainside. It is connected to the main line of the Northern Pacific Railway by means of a spur from Mountainside.

Fig. 14.

Cross Section of the Mountain House Coal Co. Mine. Park County

This field is but a half mile south of the border of the Yellowstone field. There are many mines in operation in this area, but two, however, stand out as the main producers. The larger of the two, known as the Hoffman mine, but operated by the Mountain House Coal Company, has three workable veins. This company employs between 25 and 40 men, with a monthly output of

over 1,100 tons. The coal is a splendid bituminous variety, and is undoubtedly a coking coal. It is used as a steam and domestic fuel, and every indication points to a bright future for this company. The dip of the bed is 45 degrees to the north. By putting in a few thousand dollars worth of up-to-date improvements on this property it could be made a large and profitable producer. A little east of the Hoffman mine is found the Kuntz & Cox mine. This company works between 10 and 15 men, and ship their product to Bozeman and other nearby towns.

The Trail Creek is a little known field, but it has great promise. The following is a cross-cut section of seam No. 1 of the Hoffman mine:

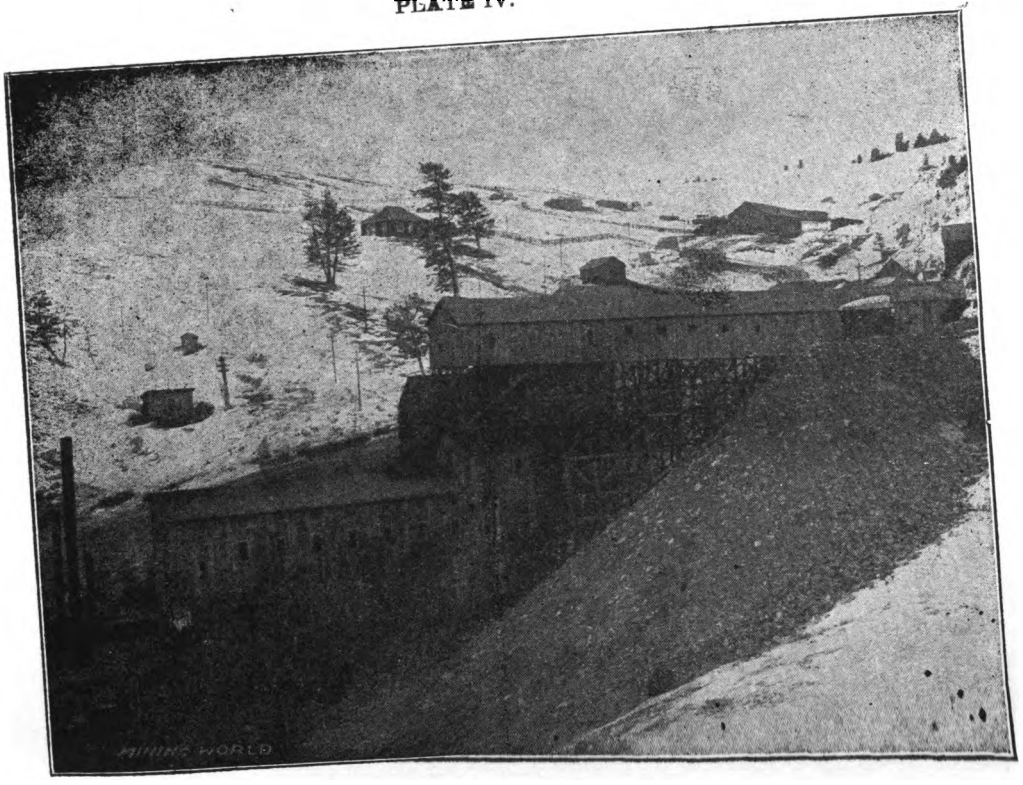
Coal	36 inches.
Sandstone	1 inch.
Coal	3 inches.
Bone	5 inches.
Sandstone	1-2 inch.
Coal	13 inches.
Sandstone	1-2 inch.
Coal	6 inches.

PARK COUNTY.

The Montana Coal and Coke Company.

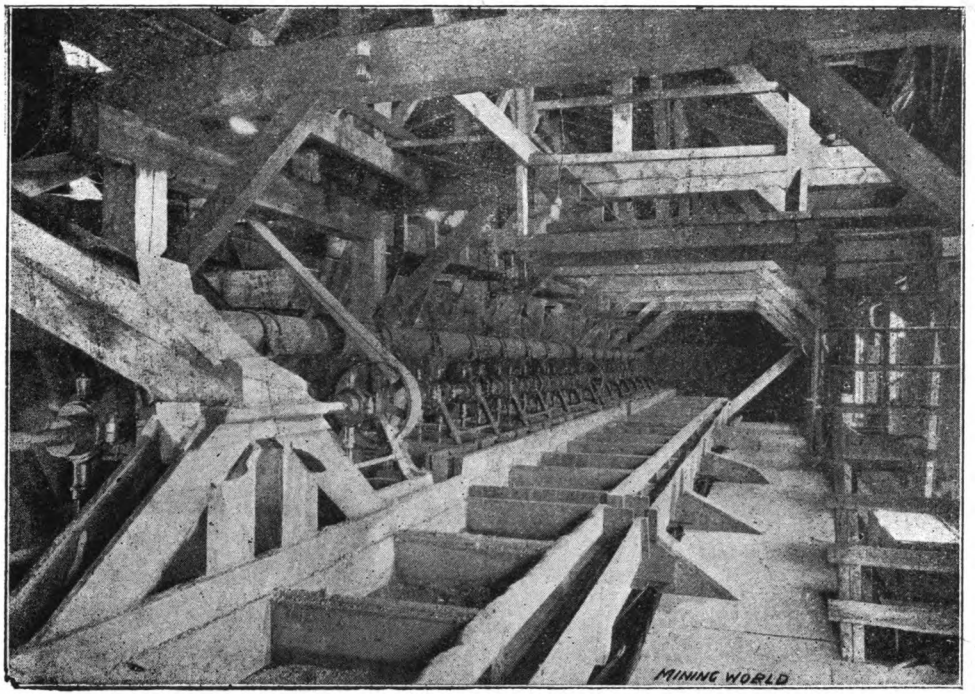
The property of this company is located in the southern part of Park County, near the Yellowstone Park. The beds of coal have been greatly disturbed in the process of mountain-making and nearby volcanoes, and is beyond the true bituminous stage. All of the coal mined is coked. There are seams of non-coking coal in this region, but owning to its difficult locality from a railroad shipping point little or none of it is at present being mined. The mines are located at Aldrich, about three miles from a railroad point, Electric, where the coke ovens, 225 in all, are situated. There has been considerable development work done at this mine, and the main entry way is in several thousand feet. All of the coal is in small pieces when mined. Pick mining, with no blasting or drilling, is the method. The coal in the bed is so fine and soft, owing to its highly metamorphosed locality, that it is very easily extracted. It is not good as a domestic fuel, but is a good blacksmith's coal. It contains very little sulphur.

PLATE IV.



Montana Coal and Coke Co. Washer at Aldrich

PLATE V.



Interior of Washer, Montana Coal and Coke Co., Aldrich, Park County.

Fig. 15.

The haulage is done by means of an electric motor in the main entry to the tipple. There are stationary electric cable hoists from the main entry; bringing the coal from the dip workings. The ventilation and drainage are fairly good.

The coal passes from the tipple to the Luhrig washer at Aldridge, and is there conveyed to the large bunkers near the coke ovens at Electric, a distance of over two miles, by means of a water sluice from 12 to 14 inches square. At present all coal must be crushed to a buckwheat size in order to send it down the flume to the bunker. The elevation from the washery to the bunker is over 1,000 feet vertical, and the flume is laid to suit the contour of the ground most of the way. From 240 to 280 tons per day of raw coal are sent to the washer, and not more than 140 to 170 tons are realized. The balance is in the impurities thrown out by the jigs, but mostly by the loss of fine coal suspended in the water going out to the rock dump and the overflow from the bunkers at Electric.

It requires about 350 gallons of water per minute. This would not be necessary in the washer, but the quantity is needed to force the coal over flat places in the flume. The more water there is used in the flume and washer the greater the loss of fine coal, as the coal does not have time to settle. There are two big settling tanks 60x200 feet, into which all of the lost coal water from the bunker is led, and after settling the coal is saved and the water is drawn off comparatively clear. This does away with the polluting of the Yellowstone River, into which it finally

The plant necessitates a chain of aerial tramways, by which any kind of coal can be dispatched to their different pockets, and only very small coal shall be used in the water. The mountains are so high the snow drifts lay for a long time, and any other haulage such as surface coal would entail greater expense as to cleaning the tracks, and when some small basin is worked out the grading, etc., is all lost, while in the aerial everything can be dis-

mounted and put up somewhere else without loss, barring the wear and tear of the rope. The latter system requires hardly any labor, as everything can be made automatic, while the surface haulage by level roads and plains will require grading, extra rolling stock, rails, locomotives and men to attend to all of these various works. The winters being severe the flumes are often frozen, which causes breaks and loss of washed coal, owing to the steep ground and the distance it takes sometimes to get to the phone and order the stopping of washing. This will be changed somewhat, and a system will be satisfactory and economical in every way will soon be installed.

The mines are lighted by electricity. The plant that furnishes the electricity is equipped with four 150-horsepower boilers, two 500-volt generators and an 800-light dynamo.

The company has built a tramway from Electric to the top of the mountain, nearly a mile long, the grade being as high in some places as 43 percent. The ordinary narrow flat car is pulled up the slope by means of an electric hoist, which serves to convey both people and supplies from Electric to the mine. At the summit of the mountain there is a trolley line running to the company store and mines.

The output of this company is about 10,000 tons of coal per month. About 1.7 tons of coal is used for one ton of coke. Each oven is charged with from 5½ to 6 tons of coal and runs 72 hours. The coke is shipped to Butte, Anaconda and Great Falls, and a little outside of the state.

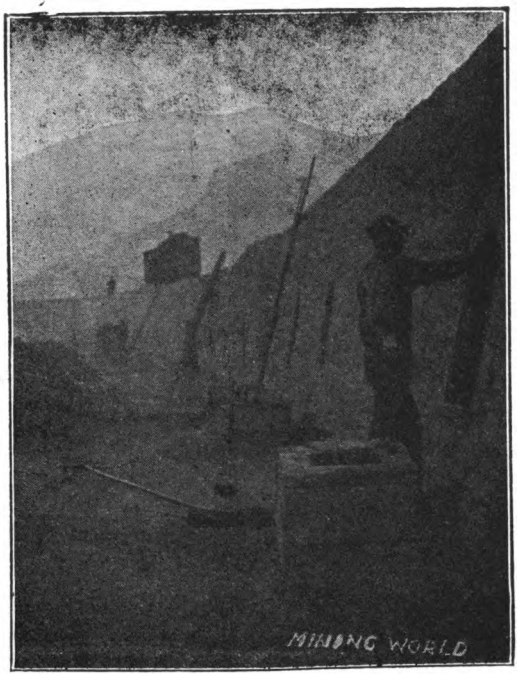
GALLATIN COUNTY.

Northwestern Improvement Co., Mountainside.

These mines are near the town of Chestnut, and have not been running long. The old Chestnut mines and surface works, owned by the same company, and the oldest coal mines in the state, have been recently abandoned. The coal seams at Mountainside have been greatly metamorphosed, and the coal is similar to that mined at Aldrich. Only one seam is now being worked. The dip varies from 30 degrees to 90 degrees, and is usually to the north, with the strike east and west. The main entry follows the dip and runs in several hundred feet.

About 95 inside and 26 outside men are employed. No mining machines are used. The mining is done entirely by pick. The coal being so fine and soft that blasting is seldom resorted to. The east and west entries are driven, and the coal is mined as at Red Lodge, mining on the upper side of the entries. At Red Lodge the cars are filled at the face of the room, while here the dip being so great the coal partially fills the lower part of each room and is drawn out by automatic doors into the coal cars on the track of each side entry.

PLATE VI.

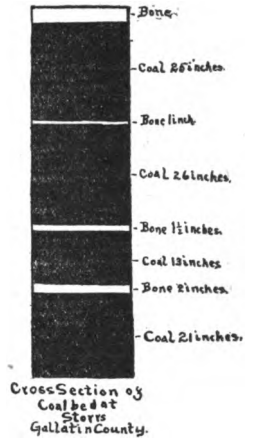


Coke Ovens, Montana Coal and Coke Co., Electric.

The cable hoist on the main entry is run by steam, while the cars are hauled from the side entires to the main entry by mules. The daily output is about 250 short tons. This coal is used entirely on the Northern Pacific Railroad engines.

The mine is fairly well ventilated, but marsh gas is quite common in some of the lower workings. The Davy & Clancy safety lamp is used in a number of places, while in other parts of the mine the ordinary miner's lamp is not dangerous. A considerable amount of water is encountered as one might suppose in a mine of such a depth and dip. This, however, is easily taken care of by using two pumps continuously. The exterior workings are new and up-to-date. A splendid tipple and a washer of 600 tons daily capacity, hand-picking tables, for removing the bone, four engines for hoisting, etc., comprise the principal exterior equipment. The coal mined here is not a good domestic fuel. While it has never been tested for coking, the writer believes it to be a fairly good coking coal.

Fig. 16.



Cross Section of Coal bed at Storrs Gallatin County.

CASCADE COUNTY.

Cottonwood Coal Company, Stockett.

In point of production this company ranked first in 1906. Owing to a fire in the Red Lodge mines during the early part of June, the production of that mine for June, July, August and September was very low. The Stockett property is owned by the Great Northern Railway Company, and about 490 men, both inside and out, are employed.

The coal is mined from a seam of the Lower Cretaceous, and is about 9½ feet thick. There are no partings between the different coal strata and the slate and bone. The seam is a hard and solid mass throughout, and contains numerous iron pyrite nodules ranging in size from a pea to 3 or 4 inches in diameter.

"There are five mine openings up here, three of which have been worked out." The coal is a low grade bituminous variety, and when washed makes a good steam and domestic coal. The seam is almost horizontal, and neither water nor gas has as yet given serious trouble. The coal is mined largely by machines. Thirty-four Harrison mining machies and twelve Rand air drills are in use. The lighting is partially by electricity. The mines are quite extensively worked, and are done so under an established system. Machine men, shooters, timbermen, track layers, loaders, etc., have their particular line of duties, and in order to maintain the output of 2,000 tons per day, with the present development, it is necessary to shoot down the coal as soon as it is ready for firing, and this keeps the air somewhat vitiated with the powder smoke. However, the mine in general is as healthy a place to work as any coal mine.

The exterior workings of this property are good. Many improvements were made during the years 1903 and 1904, chief among these being the "Bituminous Coal Breaker," finished in 1903.

This breaker is similar to the anthracite coal breakers of the east, and was erected at a cost of over $43,000. The installation of this dry spirial "washer" was necessitated by the promiscuous scattering of the "sulphur balls," or iron pyrite nodules, throughout the coal and the apparent non-parting of the coal and slate strata.

"The coal is carried from the mine to the breaker in pit cars of a capacity averaging about 1½ tons. The cars are weighed on an automatic scale and thence dumped by the cross over tipple over the bar screen, 12 feet long and 6 feet wide, and having a pitch of 6 inches to the foot, with spaces between the bars 2 inches wide, which screens out that portion already small enough —about 30 percent of the total—and, following on the shaking screen, having 1 inch round perforations, with 100 strokes per minute, removes the slack from the coal. The slack is loaded directly in the railroad cars or taken to the boiler room by means of a wire rope conveyer. The portion of the coal that goes over the shaking screen slides into a hopper, from which it feeds into an elevator consisting of a rubber belt 16 inches wide, having 8x14-inch buckets every 16 inches, and operated at a speed of 225 buckets per minute, which elevates the material to the top of the building. From here the material is handled as in most spiral washers, but on account of the slight difference in the specific gravity of the gray coal and the bone, the spirals are adjusted so as to retain only the slate and flat sulphur balls, leaving the bone to be removed by hand. The round sulphur balls, which, on account of their shape, are the first to leave the spirals and go with the coal,

also have to be removed by hand. Of 2,000 tons of the mine product which is daily dumped into the breaker, 200 tons of the various impurities are removed, and these impurities do not contain on an average of over 1 percent of coal.

Amalgamated Copper Company, Belt.

There are several properties located near Belt, but all except the Amalgamated Copper Company's coal property are of minor importance. This company employs about 370 men, and have an annual output of over 250,000 short tons. Cascade County has had the largest output of any county in the State, and part of the coal is coking. One hundred Bee Hive coke ovens, connected to the main railroad by means of a spur, are located here.

The Amalgamated property has been, and is now, extensively worked. The ventilation is fairly good, the timbering is also good, and in none of the Cascade County mines is the drainage problem a serious one. The haulage is done by means of rope cables. "There is one main tail-rope system about a mile long, running through the main entry to the tipple. As the vein of coal has many rolls, there are several independent rope systems which handle the cars from the partings nearest the working faces to the main parting." The mining is done by machines. There are now twenty-two Ingersoll-Sargent punchers in use at this mine.

Almost the entire output of this company, both coal and coke, is used at Great Falls. Some, however, is shipped to the great Washoe works at Anaconda.

The seam of coal developed at Belt is the same as at Stockett, only there seems to be more coking coal in the vein than at the latter place. The non-coking variety is a good steam and domestic fuel.

YELLOWSTONE COUNTY.

The Bull Mountain Field

This field is found within the northwestern part of Yellowstone County, and is the most isolated field in the state. It is 45 miles northeast of Billings, but is within less than 25 miles from the Northern Pacific Railroad. There are between 40,000 and 50,000 acres of coal land in this field, but it is owned principally by the Northern Pacific and the Chicago, Milwaukee & St. Paul Railroads.

The beds of coal are very promising, ranging from 6 to 16 feet in thickness. Some little activity was shown here during the past summer by the Northern Pacific people in developing their

property. The fuel is a high grade lignite or sub-bituminous coal, and will doubtless prove a good steam coal. There has been considerable talk of the Northern Pacific running a spur from the nearest point of their main line to tap the field. All indications point to this area as one of the coming good producers of the State, and with a railroad connection would doubtless rival Bear Creek or some of the other new and prosperous fields. The Chicago, Milwaukee & St. Paul Railway Company is now operating a mine at Roundup, directly north of Billings, in this field. The coal is claimed to be a good steam fuel.

Fig. 17.

Cross Section of Coal Seam. Near Darby Ravalli County.

FERGUS COUNTY.

This county is among the producers recently developed. The existence of fuel deposits in Fergus County has been known for some time. Coal has been mined for a number of years,, but only in a desultory way. Of late, however, there has been considerable activity in the coal-mining industry, and within a few years the production of this district will doubtless rival many of the older and larger producers of today. The coal field is somewhat triangular in shape and almost completely surrounded by the Judith Mountains. The coal is a fair-grade bituminous variety . The seams are not thick, but cover quite an area.

Among the most promising mines in Fergus county are the Spring Creek Coal Company, only a mile from Lewistown, the Montana Coal Company, the Sharp mine, the Stevens & Gilkerson mine, the Black Diamond mine, the Hamilton mine and others. The coal mined is used for both steam and domestic purposes. None of the mines in this part of the State are large producers. From 500 to 15,000 tons per year is the minimum and maximum production for any of the present operators.

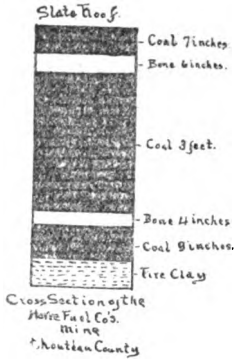
Fig. 18.

Cross Section of the Sharp Mine Fergus County.

Fig. 19.

Cross Section of the Stevens & Gilkerson Mine Fergus County.

Fig. 20.



The following table shows the output per ton of some of the larger coal operators for 1906 and the scale of wages for the same year:

SCALE OF WAGES, 8 HOURS.

Inside.

Miners	$3.60
Timberman	$3.60
Timbermen Helpers	$3.00
Track Layers	$3.60
Track Layer's Helpers	$3.00
Shooters	$3.60
Machine Runners	$3.60
Drill Helpers	3.00
Boss Driver	$3.75
Drivers (one or two horses)	$3.13
Drivers (more than two horses)	$3.35
Rope Riders	$3.50
Car Cutters	$3.00
Motormen	$3.13
Trappers	$1.25
Pipemen	$3.13
Inside Engineers	$3.13
Parting Men	$3.13
Greasers	$1.60
Unclessed	$3.00

Outside.

Engineers (first-class license)	$4.00
Other Engineers	$3.50
First Blacksmith	$4.00
Other Blacksmiths	$3.50

Blacksmith Helpers	$2.50
Head Carpenter	$4.00
Car Repairers	$3.50
Machinists	$3.50
Machinists' Helpers	$3.00
Drill Boys in Shops	$1.50
Firemen	$3.00
Ashmen	$2.50
Head Washery Men	$3.50
Jig Men	$3.00
Other Washery Men	$2.50
Weigh Men	$3.50
Pin Knockers	$2.70
Tipple Laborers	$2.50

Mining is also paid for by the ton. The price per ton is different, however, in different localities. Sometimes where the mining is easy miners have made upwards of $5.00 per day when mining by the ton. The ton is always, in Montana coal mines, the short ton of 2,000 pounds.

The following scale of wages apply to all mines operated in Montana for the year commencing October 1, 1907:

Outside.

Engineers—First Class	$4.00 per day
Engineers—Second Class	$3.50 per day
Water Tenders	$3.25 per day
Fan Firemen	$3.25 per day
Blacksmiths	$3.75 per day
Blacksmith's Helpers	$2.75 per day
Carpenters	$3.75 per day
Car Repairers	$3.50 per day
Car Repairer's Helpers	$2.75 per day
Machinists—First Class	$4.00 per day
Machinists—Second Class	$3.50 per day
Coal Inspector	$3.50 per day
Drivers	$3.00 per day
Head Dumpers	$3.00 per day
Barnmen in charge of more than 15 head of stock	$95.00 per month
Barnmen in charge of less than 15 head of stock	$80.00 per month
Teamsters	$3.00 per day
Jigmen	$3.25 per day
Other Washer Men	$2.75 per day
Greasers	$2.30 per day
Coke Men	$2.75 per day
Larry, Car Operator	$2.85 per day
Motor Men	$3.50 per day
Outside labor not classified	$2.75 per day

Inside.

Miners	$3.75 per day
Timber Men	$3.75 per day
Timber Men's Helpers	$3.25 per day
Tracklayers	$3.75 per day
Brattice Men	$3.75 per day
Shooters or Shot Firers	$3.75 per day
Machine Runners	$3.90 per day
Machine Runner's Helpers	$3.25 per day
Drillers	$3.75 per day
Driller's Helpers	$3.25 per day
Machine Repairer	$4.00 per day
Pipe Foreman	$3.75 per day
Pipemen	$3.25 per day
McGinty, repairer	$3.75 per day
Drivers	$3.60 per day
Engineers	$3.25 per day

Rope Riders	$3.40 per day
Rope Riders (main rope)	$3.75 per day
Trappers	$1.60 per day
Pick Carriers	$2.25 per day
Pumpmen	$3.75 per day
Inside labor not classified	$3.25 per day

Mining Rates Etc.

In the matter of mining rates per ton and the price coal is sold to miners, the following is the regulation for a few of the mines in the State for the coming year.

Red Lodge (Northwestern Improvement Company)—Veins 4 and 5, 62 cents per ton of 2,000 pounds mine run; vein 2, 66 cents per ton of 2,000 pounds mine run; veins 1, 1½ and 6, 74 cents per ton of 2,000 pounds mine run; cross-cuts in entries and rooms, $1.60 per yard. Lump coal is delivered to the miners at $2.25 per ton; the mine run at $2.00 per ton, and the washed coal of seams No. 1 and 2 at $1.75 per ton.

Mountainside and Chestnut—Price per ton of 2,000 pounds, 43 cents, mine run, or 63 cents per ton of clean coal. Coal is delivered for domestic purposes to employes at $2.75 per ton.

Storrs—All coal 3.75 feet and over in thickness shall be paid for at the rate of 65 cents per ton of 2,000 pounds. Cross-cuts and other places under 10 feet in width shall be paid for at the rate of 55 cents per lineal foot in addition to the coal. Where cross-cuts exceed 25 feet in length they shall be paid for at the rate of 81 cents per lineal foot.

Bridger (Bridger Coal and Improvement Company)—Machine entry work, per foot of entry, $1.10; screened coal, per 2,000 pounds, $1.00; pick entry work, per foot of entry, $1.00. Coal for domestic purposes is delivered to employes of the company at $2.50 per ton.

Trail Creek Coal Field—Mountainhouse Coal Company: Coal mined at $1.03 per car; room cross-cuts, 50 cents per foot.

Maxey Mine—Coal mined at $1.15 per car; room cross-cuts, 50 cents per foot.

Trail Creek Coal Company—Coal mined at $1.20 per car; room cross-cuts, 50 cents per foot.

Gebo—Gebo Coal Company: Pick mining, per ton of 2,000 pounds screened lump, $1.00; rooms undercut b ycompany, where the miner does the drilling, shooting, timbering and loading, 90 cents per ton of screened lump is paid. Coal is delivered to employes of the company at $2.50 per ton.

Stockett—Cottonwood Coal Company: Machine men, 2 cents per square foot for all places over 12 feet wide; machine men, 3.1 cents per square foot for places 12 feet wide and under. In deficient places machine runner and helper to be made up to average

day rate of wage for such class of work. The mine committee and pit boss decide what is a deficient place. The coal is sold to the employes at $2.00 per ton at the cleaner.

Sand Coulee—The machine rates at Sand Coulee are practically the same as at Stockett, inasmuch as the mines are operating on the same vein, and almost under the same conditions otherwise. Pick mining is paid for at the rate of 75 cents per ton of 2,000 pounds, run of mine. The screened coal is delivered to the employes at $2.50 per ton.

Belt—Amalgamated Copper Company: Pick mining, per ton of 2,000 pounds run of mine, 75 cents; loaders, per ton, run of mine, 43.5 cents; machine operators, per ton of 2,000 pounds, mine run, 11 cents. Coal is delivered to employes at $2.50 per ton.

Bear Creek—The price paid per ton at this camp for pick mining runs from 70 to 85 cents per ton of 2,000 pounds, owing to the vein mined; machine cutting, 12 feet or less, 4.25 cents per square foot; machine cutting, over 12 feet wide, 2.75 cents per square foot. Coal is sold to mine employes only at $1.75 per ton.

The mines near Lewistown, Fergus County, pay $1.50 per ton, mine run, for pick mining, and 2 cents per square foot for machine men, in all places over 12 feet wide; all places under 12 feet wide machine men get 3.1 cents per square foot. The lump coal is delivered to employes at $4.50 per ton. The mine run is sold to employes at $4.00 per ton.

There are now practically 80 coal properties, both large and small, in operation in the State. Nearly 3,500 men are employed in these properties, and the total annual output is over 2,000,000 short tons.

List of Coal Operating Properties, Shipping Facilities, Addresses etc.

CASCADE COUNTY.

Gerber mine, Ed Gerber, manager, Sand Coulee; branch of Great Northern Railroad.

Nelson-Jenks Coal Company, Robert Pettigrew, general superintendent, Sand Coulee; same railroad service.

Stainsly-Latham Coal Company, Sand Coulee; same railroad service.

Cottonwood Coal Company, James Pearson, superintendent, Stockett; same railroad service.

Matthew Richardson, Armington; branch of Great Northern Railroad (Neihart branch); team haul to railroad.

Orr Brothers, Sam Orr, manager, Belt; team haul to Great Northern Railroad.

Millard mine, H. W. Millard, manager, Belt; team haul to railroad.

Fred Schmauch & Co., Frank Calone, superintendent, Belt; team haul to railroad.

Patrick O'Neill, Belt; team haul to railroad.

Anaconda Coal Mining Company, F. W. C. Whyte, general manager, Anaconda; J. J. Kinney, resident superintendent, Belt.

Louis Dahn, Sand Coulee; team haul to railroad.

CARBON COUNTY

Northwestern Improvement Company, C. C. Anderson, general superintendent, Red Lodge; branch of Northern Pacific Railroad from Laurel.

Bituminous Coal Company, W. S. Todd, general manager, Coalville; same branch.

Killorn & Weber, George Killorn, supernitendent, Fromberg; same branch; team haul.

Bridger Coal and Improvement Company, George Hough, manager; J. W. McDonald, superintendent, Bridger; same branch.

Montana Coal and Iron Company, W. W. Worthington, superintendent, Bear Creek. This and the next following are on the Yellowstone Railroad, a line built from Bridger to the coal mines at Bear Creek.

Washoe Copper Company, F. W. C. Whyte, general manager, Anaconda; Thos. Good, superintendent, Bear Creek.

Bear Creek Coal Company, H. S. Hopka, superintendent, Bear Creek.

International Coal Company, H. Rosetta, superintendent, Bear Creek.

Smokeless and Sootless Coal Company, James Brophy, general manager, Bear Creek.

Joliet Coal and Fuel Company, "Bank of Joliet," Joliet; branch from Laurel.

CHOTEAU COUNTY

Macton Coal Company, H. L. Thompson, manager, Big Sandy; team haul to Great Northern Railroad.

Havre Coal Company, F. F. Bessout, general manager, Havre; spur from Great Northern Railroad to tipple.

C. C. Mack, Big Sandy; team haul to Great Northern Railroad.

Crook & Johnson, Chinook; team haul to Great Northern Railroad.

Raeder mine, H. Raeder, manager, Chinook; team haul to railroad.

Thornber mine, J. H. Thornber, manager, Chinook; team haul to railroad.

Burns & Cornwall, Chinook; team haul to railroad.

Pat Meany, Chinook; team haul to railroad.

CUSTER COUNTY

M. E. Hatch, Miles City; team haul to Northern Pacific Railroad.

Miles City Coal Company, Miles City; team haul to railroad.

M. O. Tracy, Ekalaka; team haul to railroad.

Elder & Pedan, Miles City; team haul to railroad.

Yellowstone Coal Company, Miles City; team haul to railroad.

Bert McCreary, Miles City; team haul to railroad.

Sam Weaver, Miles City; team haul to railroad.

DAWSON COUNTY

Edgar Higgins, Forsyth; team haul to railroad.

Chas. M. Patterson, Forsyth; team haul to railroad.

Hughes Electric Company, Glendive; team haul to railroad.

G. N. Buncick, Glendive; team haul to railroad.

FURGUS COUNTY

Spring Creek Coal Company, Robert Hendry, superintendent,

Lewistown; Montana Railroad, now a part of C., M. & St. P. R. R.

Mace mine, Thomas Phillips, manager, Maiden; team haul to railroad.

Schultz mine, Sam Schultz, manager, Utica; team haul.

Brow & Parsons, Lewistown; team haul.

Rand mine, S. G. Rand, manager, Moore team haul.

Cox & Skegg, Lewistown; team haul.

Cooper mine, B. N. Cooper, manager, Moore; team haul.

Knox & Barney, Moore; team haul.

Dan Sharp, Moore; team haul.

Shipley & Kemph, Gilt Edge; team haul.

Ed Roberts' Coal Company, Utica; team haul.

Morris & Waite, Utica; team haul.

SWEET GRASS COUNTY

William Nelson, McLeod; team haul.

BROADWATER COUNTY

Hudson & Ulm, Toston; team haul.

MEAGHER COUNTY

Max Watterman, White Sulphur Springs; team haul.

David Dorcett, Castle; team haul.

Rees & Badger, White Sulphur Springs; team haul.

PARK COUNTY

Maxey Brothers, William Maxey, superintendent, Chimney Rock; branch of Northern Pacific Railroad from Chestnut.

Trail Creek Coal Company, Joseph Bounds, superintendent, Chimney Rock; same railroad.

Anderson & Evans, T. J. Evans, superintendent, Chimney Rock; same railroad service.

Montana Coal and Coke Company, B. A. Bartl, general manager, Electric; Yellowstone Park Railroad from Livingston to the National Park.

GALLATIN COUNTY

Henry Harrison, Storrs; branch of Northern Pacific Railroad from Chestnut.

Washoe Copper Company, F. W. C. Whyte, general manager, Anaconda; Mr. Griffin, superintendent, Storrs; branch from Chestnut.

N. W. I. Company, C. C. Anderson, Red Lodge, general superintendent; George Forsyth, Chestnut, superintendent.

VALLEY COUNTY

Zono-George mine, Bruegger & Nuegent, Culbertson; team haul.
Cooper mine; team haul.
Astrope mine, Culbertson; team haul.
Dempsey mine, Culbertson; team haul.
Arnette's mine, Culbertson; team haul.
Stafford mine, Culbertson; team haul.
Ballock mine, Culbertson; team haul.
Richardson mine; team haul.
A. A. Kingsbury, Culbertson; team haul Great Northern Railroad.

YELLOWSTONE COUNTY

Republic Coal Company, Roundup, C., M. & St. P. R. R.

Production by Counties

The total production reported for ten months of 1907 is 2,030,564 tons. Nearly 13 percent increase over the corresponding period of 1906.

Number of men employed in the coal mines of Montana for 1907:

Total production of coal by counties for 1907:

Park	91,674 short tons.
Gallatin	79,106 short tons.
Fergus	35,722 short tons.
Cascade	1,068,257 short tons.
Choteau	13,769 short tons.
Carbon	734,444 short tons.
Custer	7,142 short tons.
Valley	300 short tons.
Yellowstone	150 short tons.
Total	2,030,564 short tons.

Gypsum Deposits

Little has ever been written concerning the gypsum deposits of Montana, as the discovery and development of the economic beds in the state date back but a few years. Perhaps the first commercial use made of native gypsum in the State was in the year 1894, and the first discovery the year previous. The State, however, can boast of as large gypsum deposits as any state in the Union, and in a few years this natural resource will be of great benefit to her citizens.

The economic deposits in Montana may be divided into three general fields—the north, middle and south fields. These fields follow the contour of the mountains and run from northwest to southeast across the State.

Little is known of the middle field, but it is claimed that some good deposits are located near Lime Spur, Jefferson County, Montana.

The north field is located in the counties of Cascade and Fergus. Two large deposits are found in this field. One deposit near the towns of Armington and Kibby, in Casacde County, and the other in the Big Snowy Mountains of Fergus County, near Portuguese. The south field is located in Carbon County, near Bridger.

The selenite variety of gypsum is found in all the counties of Montana east of the Rockies.It occurs in the upper Cretaceous formation, but seldom is found in commercial quantities. "Very commonly it impregnates the waters, both of streams and springs, making them unfit for use. At Hunters Hot Springs, on the north bank of the Yellowstone river, about 20 miles east of Livingston, the hot waters are now depositing gypsum, and the old hot springs fissures are filled by a mass of gypsum and stilbite. Up to the present time these deposits, although of considerable extent, have not been utilized."*

During the summer of 1902 the writer found a vein of selenite in the southern part of Fergus County, near Folsom, which was about 18 inches thick. This deposit is in the Laramie. Many such places occur in the State, but the areas are small and do not warrant an attempt at commercial production. Excellent crystals of selenite gypsum are found in quite large quantities in the Laramie clays of Dawson County, near the town of Wibaux, and on Glendive Creek, about 12 miles southeast of Glendive. Also near Drummond, Granite County, and near Bear Paw Mountains, in Choteau County. The crystals are common 3 1-2 miles south of Wibaux, and are found on the east bank of Beaver Creek, on the old Homer Squyers ranch. They are for the most part exposed in the little rain-eroded ditches, lying on the surface.

*Weed Bulletin No. 223, U. S. Geological Survey.

The length of the crystal-bearing clay is about 500 yards and about 10 feet thick. Many twin crystals occur, and besides these four distinct forms are noted.

Several chemical analyses were made of these crystals and two of the results are given below:

1. Analysis

H_2O	20.02 per cent
CaO	32.86 per cent
SO_3	46.95 per cent
Total	99.83 per cent

2. Analysis

H_2O	20.08 per cent
CaO	32.86 per cent
CO_3	46.94 per cent
Total	99.88 per cent

Alabaster gypsum crystals are found 14 miles west of Wibaux, Montana, in the "Band Lands" of Glendive Creek, Dawson County. The butte on which the crystals are found is one of the highest in this region, and is capped by a scoriaceous volcanic rock. The crystals are found about 30 feet below in a "gumbo" clay. The crystals are found in the Laramie formation.

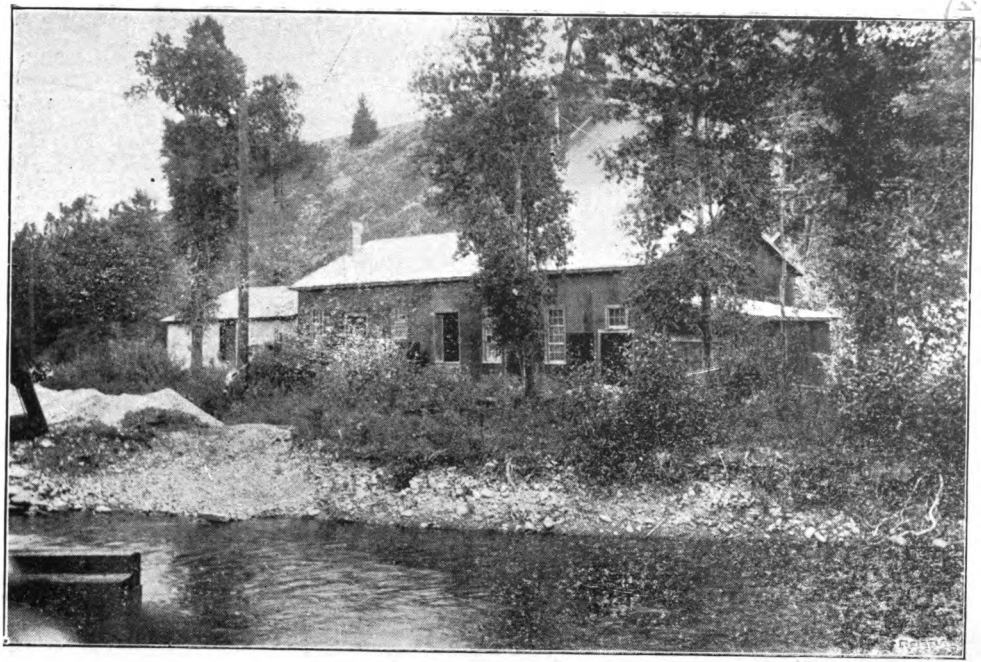
The north and south beds are the only ones being worked at present, and only one mill is being operated at each place.

The North Field.

The principal beds now being worked in this field are located in the northwestern part of Cascade County, and cover quite a large area. According to Weed "the series of beds may be traced from the Missouri River eastward along the flanks of the Big Belt mountains to Riceville, on the Neihart branch of the Great Northern Railway; thence eastward to the town of Kibby, and thence around the flank of the Little Belt mountains in a nearly continuous exposure to the vicinity of Castle Mountains. Southward from that locality the same horizon can be traced by its red shales, but gypsum does not occur, so far as known, in sufficient purity or thickness to promise commercial importance."

This field was visited during the summer of 1905 and found to be in a flourishing condition. Mr. A. J. Voight, the present president and manager of the only stucco and plaster of Paris mill in this field, made it possible for the writer to investigate the beds and mill and closely examine the products. Mr. Voight

PLATE VII.



Gypsum Mill, near Armington, Cascade County

formerly owned and managed the Kibby plant, but after this latter burned, the beds nine miles northwest of Kibby and six miles above Armington were opened, and in 1900 the new, or present, plant was installed.

The Mill.

"The mill of this plant is located directly on the Neihart branch of the Montana Central Railway six miles above Armington on Belt Creek, and 34 miles from Great Falls. The mine is directly back of it, and sufficiently high on the hillside so that gravity is largely helpful in handling the rock. Sometime back, wagons were used in transporting the rock gypsum from the mines to the mill, but there was installed during the past summer a gravity tram car system which greatly facilitates this part of the work and somewhat lessens the expense of transporting the raw material. The gypsum is dumped into an immense bin and "directly from the rock bin" it is passed "through a 12x14-inch Blake crusher, which crushes it to about one inch; then through a Gates crusher, which reduces it to one-quarter of an inch; then it is elevated to a trommel, which separates the coarse from the fine, all over 40-mesh going down through a gravity pipe into a French burr, which reduces everything to 40-mesh or fifiner; from the burr it is again elevated to the same separator, whence it travels by gravity to a bin over the calciner. The calciner holds about three tons, and in this mechanism the gypsum is dehydrated by subjecting it to heat at 260 degrees Fahrenheit for two and one-half hours usually. From here the plaster of Paris is conducted to a storage bin, where a retarder and hair are added, then through a Broughton mixer, which finishes the stucco process. The capacity of the mill is 30 tons per day of 24 hours. This it regularly turns out, and the product is loaded directly into the railroad cars for shipment. More than one-half goes to Seattle and Spokane, the balance being marketed at Great Falls, Butte, Missoula, Helena" and other Montana towns.

This mill is by far the better equipped and capacious of the two now operating in the state.

Stucco or wall plaster from this mill was used in the
Victoria building, Spokane, Washington.
U. S. Postoffice, Helena, Montana.
U. S. Postoffice, Butte, Montana.
State Capitol, Helena, Montana.
Hennessy Mercantile Co., Butte, Montana.
Courthouse, Great Falls, Montana.
Courthouse, Kalispell, Montana.
Masonic Temple, Butte, Montana.
Yerrick building, Missoula, Montana, and many others.

The above readily shows that the Montana products are equal to the eastern product, and is being quite generally used throughout the northwest.

The company operating this mill or the "Montana Aluminum Plaster Co.," manufactures five different products from the raw gypsum—stucco, plaster of Paris, aluminum hard finish plaster, sand plaster and calcimine of various colors. The annual product from this plant is about 1,800 tons.

The mill and mines are lighted with electricity, generated by means of a small dynamo at one end of the mill. The mill at present is run by steam, but the company expect to dam Belt Creek, and thus run on a more economical basis. The mill is within twenty yards of the railroad, thirty yards of the creek, and fifty yards of the mine. Everything is ideal for a plant of this sort.

The Gypsum Beds.

The beds here are between 25 and 30 feet thick, and extend over an immense area. They are nearly horizontal, having a slight dip to the northwest. The gypsum itself is quite pure (see analyses) but is interstratified somewhat in places with considerable clay.

The gypsum is not more than from 100 to 300 feet below the surface, and rests upon a hard compact limestone. Several fossils were gathered from rocks directly above the beds and sent to the U. S. National Museum for specific identification, and the horizon was pronounced as Jurassic. Weed identified the formation below the beds as lower Carboniferous.

From the dip, geological formation, and other indications, the beds here are probably the same as at Kibby, nine miles away. If this be true the field at this place has by far the largest productive area of any in the state. The beds thin out to a few feet at Kibby, and most of the material worked there was exposed.

The other bed that belongs to this, or the middle field, is located in the Big Snowy mountains, near Portuguese, about 35 miles south of Lewistown, Fergus County. The material is a splendid quality of alabaster, perhaps as pure as any in the United States, and it is claimed that an immense ledge is exposed. No development of any consequence has ever been done here, but since the railroad now passes within a few miles of the deposits good use is expected soon to be made of them.

The Middle Field.

This field is located about two miles east of Lime Spur, a flag station on the main line of the Northern Pacific Railroad. It is not well known, nor has it been much prospected. The writer

PLATE VIII.

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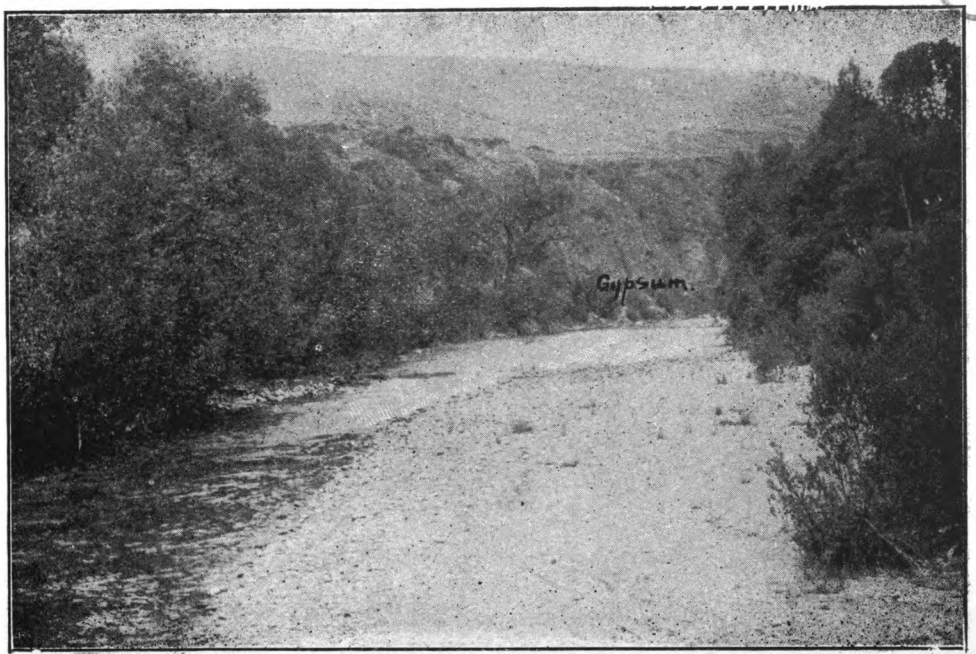


Gypsum Outcrop near Armington, Cascade County.

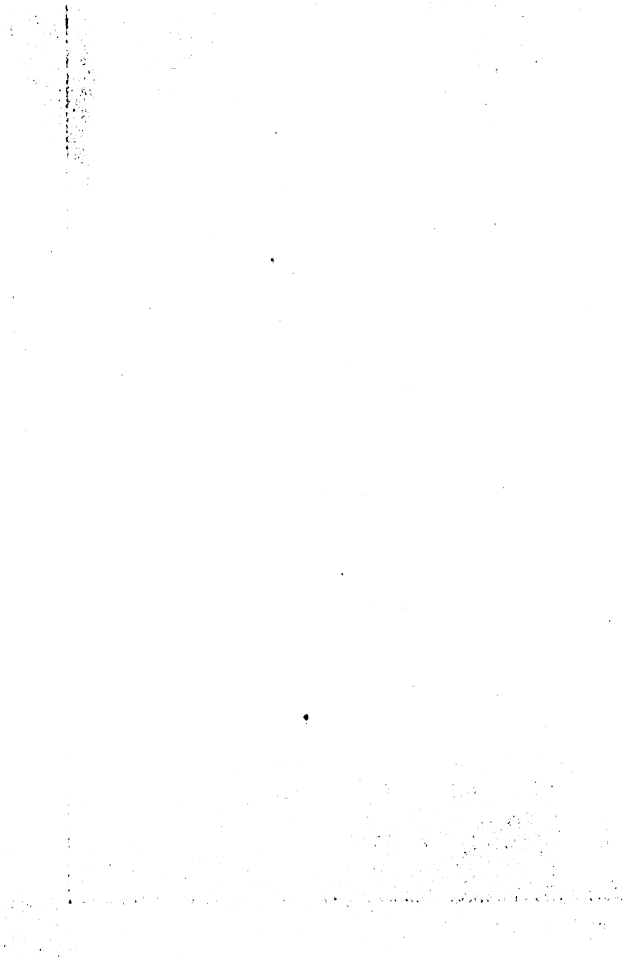
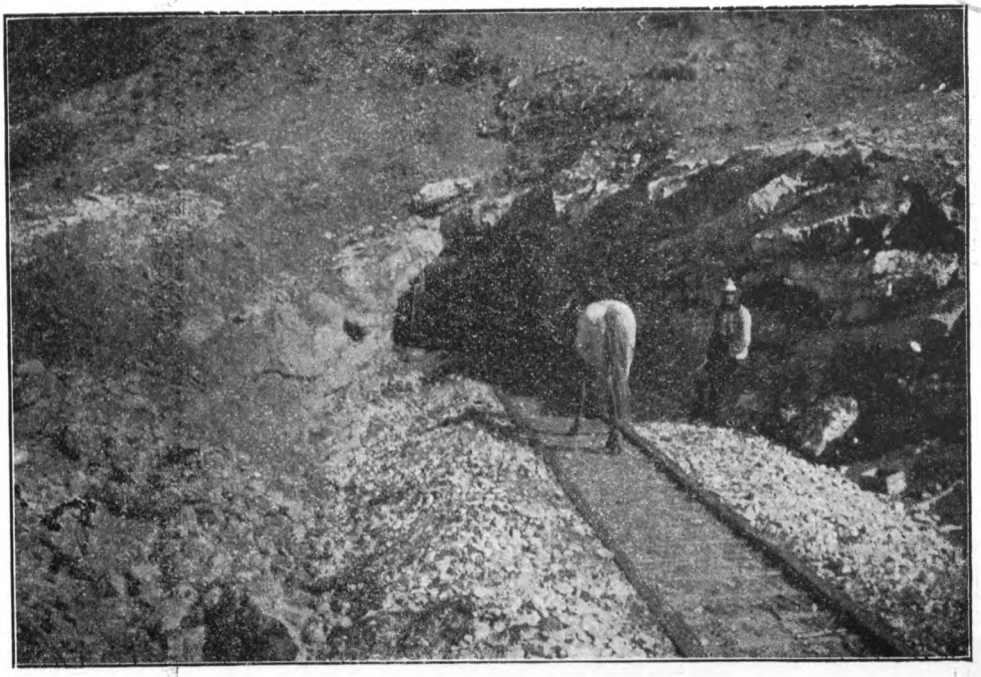


PLATE IX.



Gypsum Mine near Bridger, Carbon County.

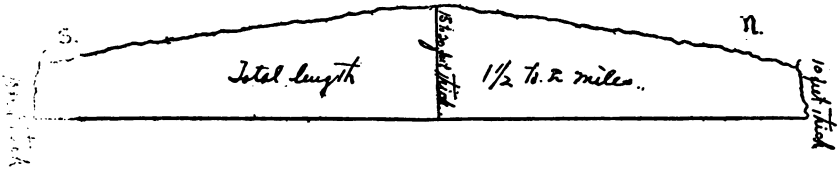
visited some of the deposits in this field last August. While but half a day was spent on the examination, several fairly good outcrops were found. Some prospect pits showed a fair thickness and a good variety of rock gypsum. Some gypsite also occurs here. The claims are owned by Messrs. Lee Robertson, Bert Carlton, Ivy McPherson and E. C. Woodward. The geological formation is similar to that of the other fields. This field warrants a more careful investigation.

The South Field.

The productive part of this field is located wholly within Carbon County, and "this series of beds then extend southward into the Big Hole Basin, and can be traced into the mountains of Wyoming." There are three exceptionally fine outcrops in this field. At present only one of the three is being worked. The smallest of *first* outcrop, of this field is located about eight miles south and east of Bridger, and at this outcrop is located the only other gypsum plant in the state. The mill is much smaller, but similar to the one near Armington. From 10 to 15 men are employed at the mill and in the mines, and the products, plaster of Paris and stucco, are hauled to Bridger, from where it is shipped by rail to various points in the state. The annual output from this plant is very much smaller than at Armington. The mine is located nearly a half mile from the mill, and the raw gypsum is hauled this distance also. The deposit that is being worked is from 10 to 12 feet thick, and is fairly pure gypsum. A tunnel (see cut) is run into the vein about 300 feet, and the rock after being blasted down is hauled out by means of tram cars or ordinary steel rails.

The beds dip considerably to the northeast, and form part of a beautiful antecline (see cut). Beneath the gypsum several feet, near the apex of the antecline exceptionally good oil shale is found. This gypsum deposit has been worked for sometime, but owing to the distance from a railroad and the high price of teaming, it is not an extremely profitable undertaking. The refined gypsum products cost $4 per ton freight in shipping to any of the large cities of the state, and the material itself sells for about twice that figure. With high teaming rates and one-half of the selling price taken for freight, a no large profit is made on the material. However, it is paying a small dividend, and the mill still continues to run. The altitude of this bed is about 4,200 feet.

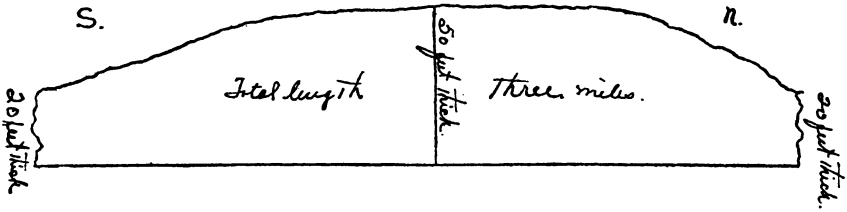
The *second* outcrop is between 8 and 10 (see sketch) miles from the first, and while it has never been developed to any great extent, it has been worked enough to show that it is much better



Longitudinal Section of Deposit near Bowler

d as free from interstratified clay as the first deposit. The psum is as pure as the former, and the area of the bed much eater. A splendid outcrop of from one to two miles is shown d the bed is from 15 to 200 feet thick. It is quite near the uthern border of Carbon County, and also of the State, and only ne and one-half miles from Bowler, a station on the Cody branch f the B. & M. Railway. This is a good deposit, and a Spur from owler could be run to the bed with but very little grading. It ill not be long until a mill will be placed at this outcrop to han- lle the immense deposit. Near the solid gypsum of this area is found a splendid deposit of gypsite. This alone makes the prop- erty of considerable value.

The *third* and by far the most promising and largest bed of this field, and the thickest, if not the best, inthe state, is located about 16 miles south and east of Bridger, and 4 or 5 miles north of the *second outcrop.* This deposit is owned by Messrs. Hanley & Haugh of Bridger as is also the one near Bowler. This bed is an exceptionally fine one. At the southern outcrop its thickness is about 20 feet and it gradually grows thicker to the northward, until it reaches a maximum thickness of 50 feet. This is about 1½ miles from the first southern outcrop. The maximum thickness continues for some distance when a gradual thinning out begins until about three miles north of the first outcrop, where the thickness is about 15 feet. The deposit has a north and south strike, and dips a few degrees to the southwest. The material is as pure and the beds as free from clay as any in the State.

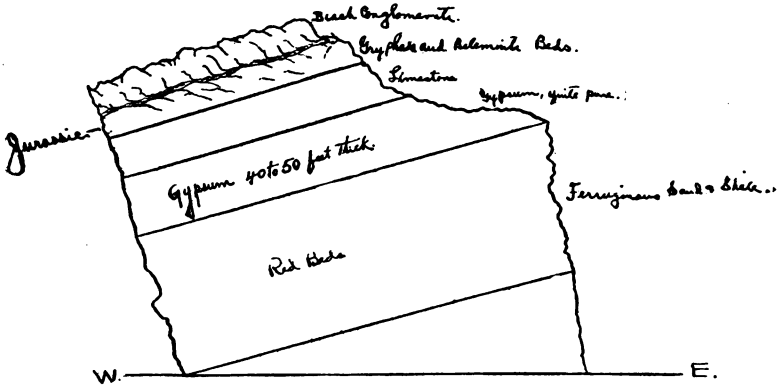


Longitudinal Section of Deposit near Crocket

It lies immediately on the "Red Beds," or a red sand shale formation. The "Red Beds" in this region are from 400 to 600 feet thick, having a northwest and southeast strike and continuing for many miles. The gypsum outcrops, which cap the

"Red Beds," may be traced for at least 15 miles. The beds are undoubtedly the same geological formation and also a continuation of the gypsum beds farther south in Wyoming.

This bed is about 4½ miles from Crocket, a station on the B. & M. Railroad branch line to Cody. The altitude of the bed is 4,800 feet. The valley through which the railroad passes is probably 400 to 600 feet lower than the gypsum outcrop. From Crocket to the base of the cliff, on which the gypsum occurs, is almost perfectly level, making thereby an easy transportation of the gypsum or gypsum products to the railroad. The gypsum at this place is capped by a hard thick limestone. This limestone formation is exposed to the west, and the surface rock covers several hundred acres. The limestone is covered in some places by a thick formation, bearing numerous Gryphea and Belemnites, and again above this is found a very hard compact reddish conglomerate with grains varying in size form a hickory nut down.



Cross Section of Bed Near Crocket

This last gypsum deposit is such a promising proposition that a mill is expected to be placed on the property and in operation within another year. Negotiations for the claims have been pending for some time, and it is expected that a large eastern company will soon close the deal and actual development work begin.

It thus may readily be seen that the commercially productive gypsum deposits lie on the eastern base of the Rocky Mountains, or, in other words, on the foothills of the main range. It may also be seen that the deposits are numerous, quite thick and fairly free from impurities. They also have a wide range, running two-thirds the way across the State from northwest to southeast, thus making it possible to compete in every town in the State with outside products.

Geological Formation of the Gypsum Deposits.

According to Weed, the northern field belongs to the lower carboniferous.The writer collected several good fossils from this locality during the past summer, and found that the gypsum deposits lie directly upon lower carbonferous limestone. Farther west this dips under the Jurassic, and this still farther west dips under the Cretaceous. According to Darton the south beds rest immediately upon the Permian, inasmuch as they rest upon the typical "Red Beds." There is no Paleontological evidence here that the "Red Beds" are Permian, but immediately above the gypsum deposits, stratigraphically and paleontologically the formations belong to the Jurassic. Fisher, of the U. S. Geological Survey, calls the formation containing the gypsum beds, both in Mountain and Wyoming, the Chugwater, which is supposed to be Triassic. It is the writer's opinion from recent study that all of the gypsum beds in Montana belong to the same geological formation. and that formation is probably the Triassic.

Machinery

According to the Geological Survey the following machinery is necessary to manufacture 100 tons of plaster per day:

1. A crusher; estimated cost, $1,000.

2. One direct heat drier, 48 inches in diameter and 27 feet long, together with one dust room; estimated cost, $2,500.

3. One pot or bowl crusher for fine grinding the material after drying; estimated cost, $300.

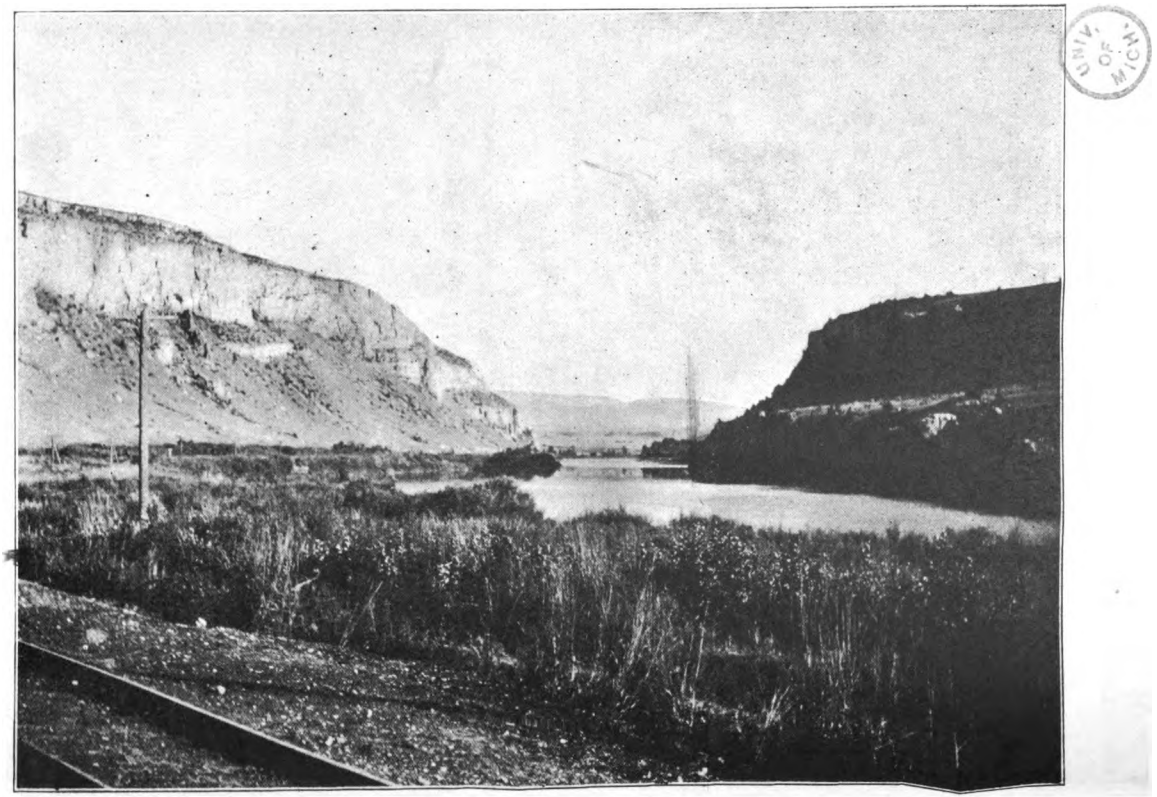
4. Four French burstones for grinding; cost, about $300 each.

5. Two calcining kettles, $200 each.

In addition to the above mentioned machinery the necessary elevators, conveyors, shafting, belting, and bins are required. On account of the nature of the process and material, the bins, elevators, and conveyors should be made of steel, and the entire plant should be as nearly fire-proof as practicable,"

The following chemical analyses of the Armington and Bowler gypsums were made by Mr. W. O. Dickinson, B. S., former assistant in the department of chemistry of the University of Montana:

PLATE X.



UNIV. OF MICH.

Limestone Cliffs, Lombard, Broadwater County.

Near Armington, Montana

CaO	33.101	per cent
SO3	45.939	per cent
H2O	20.960	per cent
Total	100,000	per cent

Near Boulder, Montana

CaO	33.023	per cent
SO3	45.935	per cent
H2O	21.042	per cent
Total	100,000	per cent

In conclusion it may be said that while Montana has several splendid gypsum deposits, her gypsum industry is still in its infancy. However, with the increasing demand for gypsum products, few years will pass before many of the idle beds of today will be turned into the refined marketable material.

LIME

The lime burned in the State is not a very large percent of the amount used, there being at present but 10 or 12 kilns in operation. There are many deposits of good limestone, however, but most of them are not near railroad transportation, and hence their being worked with profit is generally prohibited.

The process of preparing the raw lime stone rock for lime is generally as follows:

The limestone is quarried and dumped in the kiln, which holds generally several tons, and then burned. When the limestone is burned of calcined at a sufficiently high temperature it loses its water, carbon dioxide and other volatile constituents, and becomes more or less porous. If heated too high the material fuses and is of no use as lime. This burned limestone is called "quick lime," or simply lime (CaO) and has a great affinity for water.

Where quick lime is mixed with water it cracks and pops, swells up, becomes hot (slakes), forming a hydrate of lime. The purer the limestone the better "quick lime" will it make. Limestone rocks containing iron oxide, magnesium cabronate, or clay impurities do not make good lime. When quick lime is exposed to the air it takes up water vapor and carbonic acid and becomes air slacked. In this form it is generally a powder instead of lumps or pieces.

The limestones burned in the State for quick lime are nearly all of a dark color and quite pure. The kiln near Dillon has some almost white limestone in the quarry. This is an exception, however, to the general rule.

The lime kilns now operating in Montana are as follows: *Two* near Elliston, a few miles west of Blossburg. At this place the larger kiln of the two is located directly at the quarry and also

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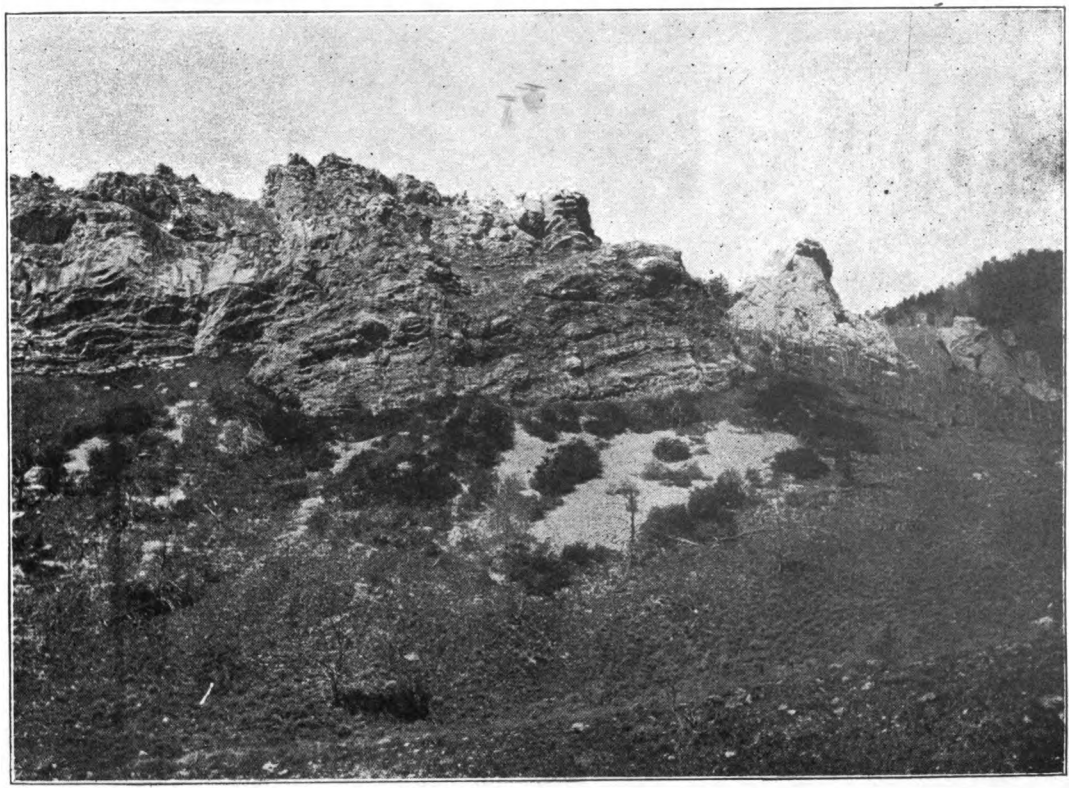
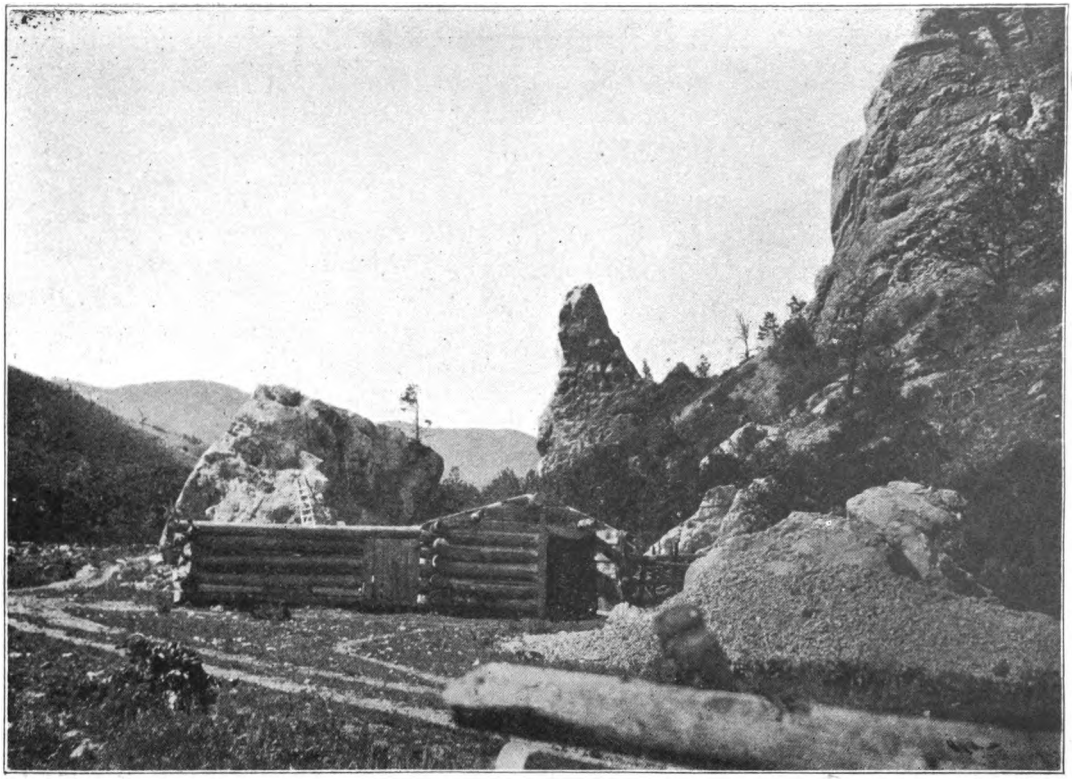
Limestone Outcrop, near Lewistown, Fergus County.

Lime Kiln, near Lewistown, Fergus County.

PLATE XIII.



Limestone Outcrop, near Red Lodge, Carbon County.



Limestone Ledge, Near Red Lodge, Carbon County

on the Northern Pacifific railroad. This kiln has been running for several years, and a good grade of lime is made. The early operators burned the lime by means of a rather crude brick and stone kiln, using wood as a fuel. A large metal kiln is now in use, and the fuel is for the most part coal. The smaller kiln at this place is of the same type as the large one, but located between two to three hundred yards from the track. The smaller kiln at that is being worked is quite pure, and there is a large quantity of it. These kilns are in Lewis and Clark County.

Another fairly large producer is in Cascade County, on the Neihart branch of the Great Northern Railroad or the Montana Central. The kiln has been in operation for a number of years, and the limestone deposit is almost inexhaustible.

The *fourth* kiln, which is rather crude, but nevertheless turns out good lime, is located about 9 miles northeast of Lewistown, Fergus County. Five burnings per year is the record of this kiln, and its capacity is 1,500 bushels. The time for burning each kiln is from 8 to 10 days. Five men are employed. The lime is hauled to Lewistown and sold for 50 cents per bushel. The limestone deposit is large and quite pure, and belongs to the Carboniferous formation.

The *fifth* and *sixth* kilns are found near Red Lodge, Carbon County. The one visited by the writer is only about four miles from town, on the northhwest bank of the Rocky Fork Creek, and a part of the foothills of the Beartooth Mountains. The kiln is crude, however, about $1,500 to $2,000 are made each year by the owner. The limestone deposit belongs to the Carboniferous formation, and the outcrops may be seen for miles standing out in bold relief as compared to the surrounding country. The other kiln is nearer town, but burns about the same amount of lime each year.

The *seventh* kiln is about 20 mlies northwest of Dillon, Beaverhead County, and located on Birch Creek. The kiln is known as the Farlan Lenee kiln, and is owned by A. M. Mast. The kiln has been in opertaion for 11 years, and is rather crude in construction. It has a capacity of 450 bushels, and takes but 96 hours to complete the burning process. Wood is the fuel used in burning the lime. The limestone deposit is directly above the

kiln, and extremely handy to work. The limestone ledge is about 250 feet wide and extends a mile or more in length. The kiln is only worked during the summer and fall, and the output is between 4,000 and 5,000 bushels per year. The lime is hauled to Dillon and sold at $.40 per bushel.

All the limestone deposits now being used for lime are found in the Carboniferous formation.

Some of the other places in the State where lime has been burned are Maiden Rock Spur on the O. S. L. railroad—two kilns. Also at Divide on the O. S. L.—one kiln. One kiln, recently operated, at Lime Spur, near Whitehall, D. A. Morrison, manager. An immense ledge of limestone is found at this place. Another kiln which is now in operation is located about 25 miles southwest of Big Timber, on the East Boulder river, near McLeod postoffice. The kiln is owned and operated by Martin & Anderson, and the lime is hauled to Big Timber, where it is sold for 40 to 50 cents per bushel.

Lime kilns have been built in the canyons south of Bozeman, and at many other localities near the city, and they furnish a fair quantity of lime for building purposes.

The limestones of the Carboniferous in Park County afford a satisfactory quantity of lime, and they are quarried and burnt at two localities—Bridger Canyon and the canyon of the Yellowstone, south of Livingston. The limestones of the Cambrian yeild a magnesian lime. The travertine, near Gardner*, is a very pure carbonate of lime, and has been used for lime making.

One of the best and purest limestone deposits in the State is located about four miles west of Anaconda. This deposit is quite extensively worked by the Amalgamated Copper Co., and the material is used in the Washoe Smelter. The deposit is connected with the smelter by means of a railroad, and many carloads are shipped for use each day.

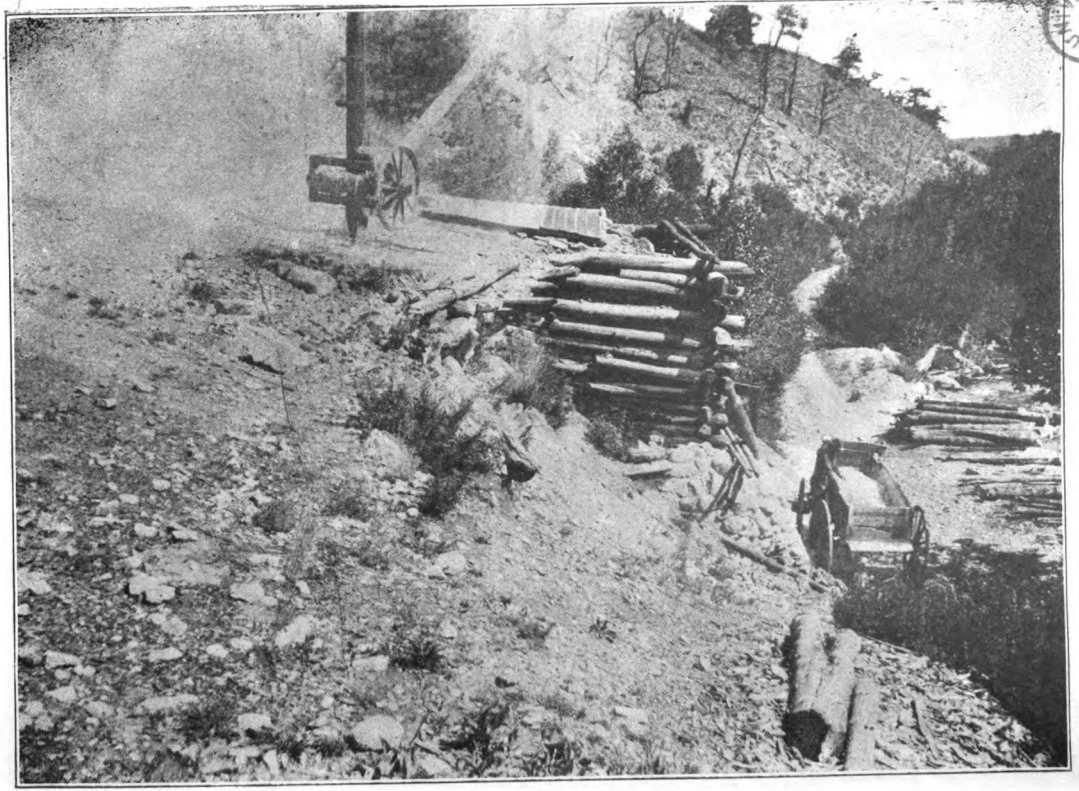
According to the United States Geological Survey the amount of lime burned in Montana in short tons, and its value, is as follows:

Quantity	4,745 short tons.
Value	$30,098.
Average price per ton	$6.34.

Many of the limestone deposits in the State are now being investigated for use in the beet sugar refineries.

The value of the total production of lime in the United States for 1906 was over $12,480,000. Montana's little production is a very small amount of the total. However, the limestone deposits are in the State, and some day many of them will be used.

*Livingston Folio U. S. G. S.



Lime Kiln near Red Lodge, Carbon County.

Quarrying Friable Sandstone, Daily Spur, Beaverhead County.

PLATE XVII.

Reservoir Sandstone Quarry, near Dillon, Beaverhead County.

Montana Building Stone

The building stones of Montana have never before been written about, and outside of the State but one or two quarries are known and these are known only in a small way. The State is well supplied, however, with many verieties of good building stones. East of the Rocky Mountains the rock is mostly sandstone, and is usually found in the upper Cretaceous formations. In the western portion the stones are found mostly in lower strata, usually Carboniferous, Cambrian and Archean, and granite, quartzite, limestone and phyllite are the principal kinds of rock. In a few places, especially in the mountain valleys of the western third of the State, Volcanic Ash is used for building purposes, and is found mostly in the Neocene formations. Some excellent quarries have been opened in each of these localities, and when the State increases enough in population, probably a decade or two, to demand large quantities of building stones, many quarries will be opened and the industry become quite valuable. Like many another non-metallic natural product of Montana, the building stones have been neglected. While the industry is not of prime importance as yet, it is gradually increasing in strength and is becoming recognized as one of the staple natural products.

Many of the substantial buildings of the State are now being built from home-quarried and dressed building stones and bricks made from home clays, burned by home coals and lignites. It is only a matter of a few years until the buildings of Montana, large or small, private or public, will be built and finished with Montana material.

A short description of building stones of the State, taken up by counties, will now be given, with illustrations of some of the most important quarries and buildings constructed from the products of these quarries.

From Wibaux, the extreme eastern part of the State, to Livingston, near the main range of the Rockies, about 350 miles to the westward, is found at almost every town, a quarry of more or less importance. These quarries turn out sandstone of various colors and hardness, some fine grained, and some coarse and slightly friable. From Helena, on the eastern slope of the Rockies, to the Bitter Root Mountains on the west, both north and south are found granite, phyllite and quartzite in large quantities and at many localities.

SANDSTONE

There are between twelve and fifteen counties in the state now quarrying sandstone. Some of these have well developed quarries, and others are opened only enough to show the character of the rock.

BEAVERHEAD COUNTY

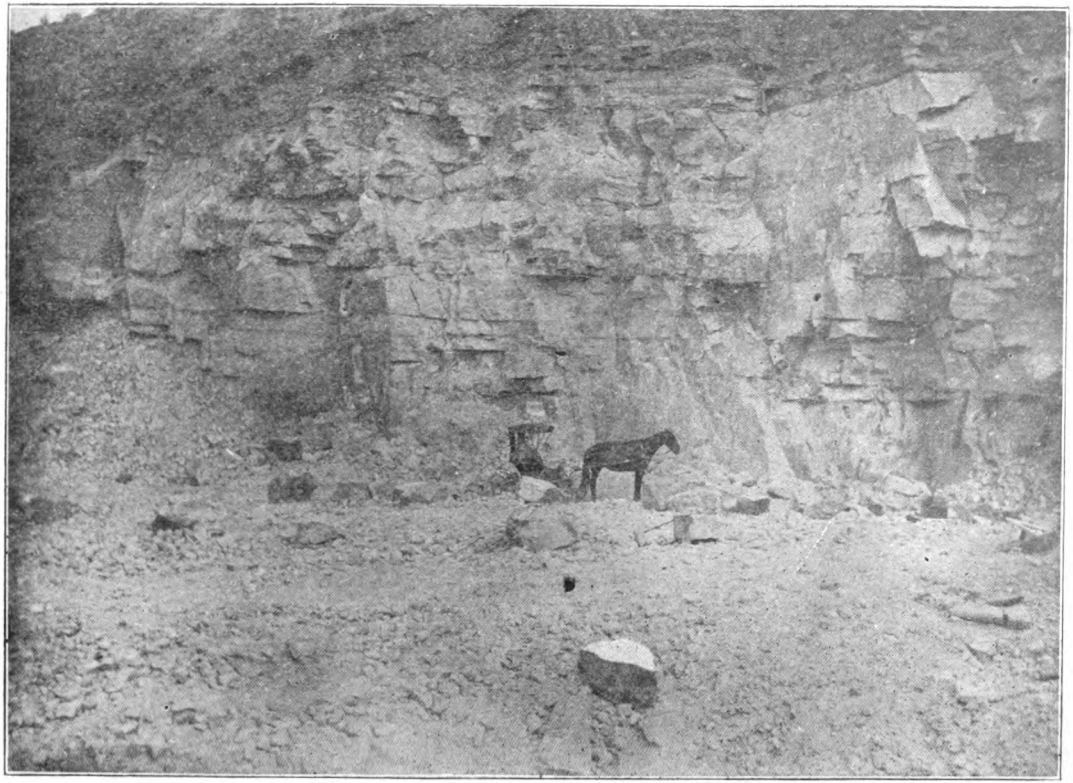
The sandstone quarries in this county are among the most promising in the State. The stone known as the Daily Spur rock is located about 15 miles southwest of Dillon on the O. S. L. Railroad. Some of this stone has a high crushing power, is very fine grained and has a light gray color. The quarries are found on either side of the railroad, and the deposit is quite extensive. The rock has a siliceous cement, and is without doubt one of the best, if not the best, sandstone in the state. The main quarry is fairly well developed and the product has been used in many of the best buildings in Dillon. Part of the new State Normal building is being built of this stone. Also some of the best buildings in Salt Lake City are constructed wholly or in part from this rock. It is little know noutside of Beaverhead County, but it is sure to have a wide range of use within a few years. The softer, purer and whiter variety is shipped to the Washoe smelter, Anaconda, for flux. The rock has splendid jointing and quarries out into beautiful rectangular blocks. The soft kind is without doubt the purest quartz sandstone in the state. When crushed it very much resembles glass sand, and undoubtedly would be good for that purpose. The quarry is owned by the Amalgamated Copper Company, and several car loads of friable stone are shipped to their large smelter in Anaconda.

Another good sandstone quarry in this county is found 5 miles west of Dillon, known as the Rattlesnake or Reservoir region. The stone found here is also an excellent building stone. It is fine grained, a brownnish reddish color, being cemented with silicia and iron, and a high crushing power. The quarry is not so well developed as the Daily Spur quarry, but enough work has been done to show the extent and character of the rock. This is the second stone the writer has seen in the State that would make a good Flag stone. The jointing and rift are almost perfect, and excellent pieces of almost any thickness and size can be quarried. This quarry is located 5 miles from a railroad, but the hauling is not difficult. The stone is used somewhat in Dillon, but not as much as the Daily Spur and some others.

There are a good many other outcrops of sandstone in this county, but so far none have been quarried to any extent.

CARBON COUNTY

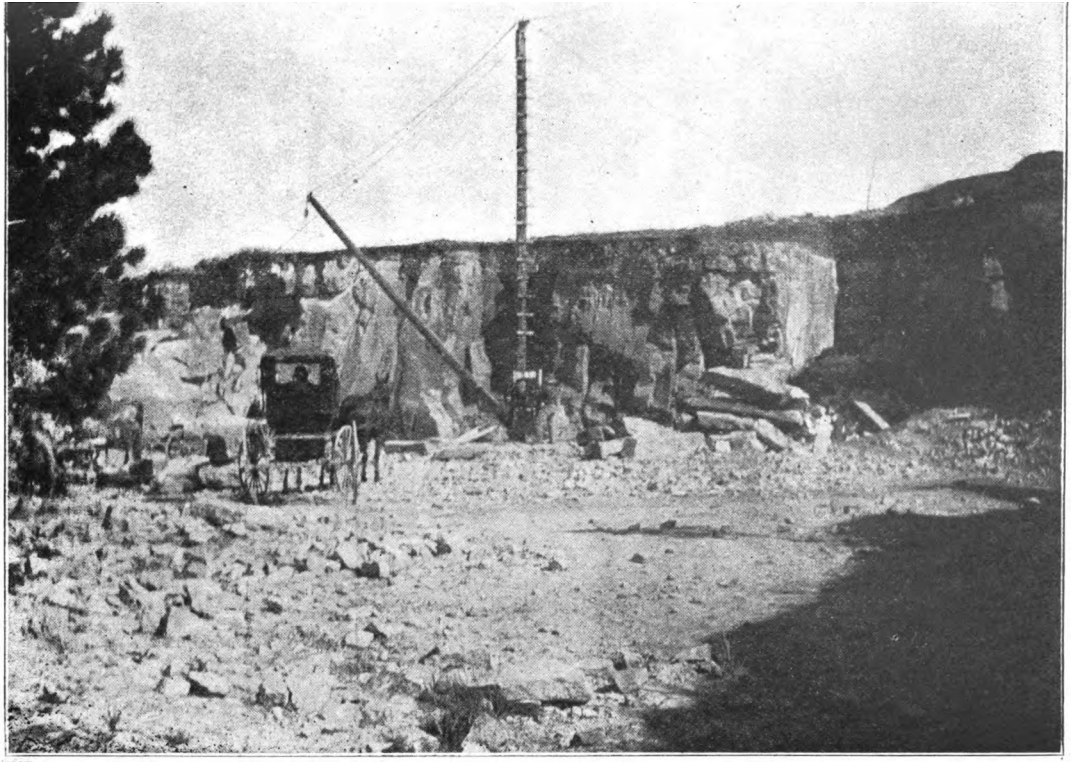
This county is well supplied with natural products, being one of the best sources of coal in the state; having large quick lime ledges, plenty of brick clay, the best gypsum deposits in the state, and thick and extensive ledges of Laramie sandstone. There are quarries at Red Lodge, Gebo and Bridger, but only at the latter



Sandstone Quarry, near Havre, Choteau County.

PLATE XIX.

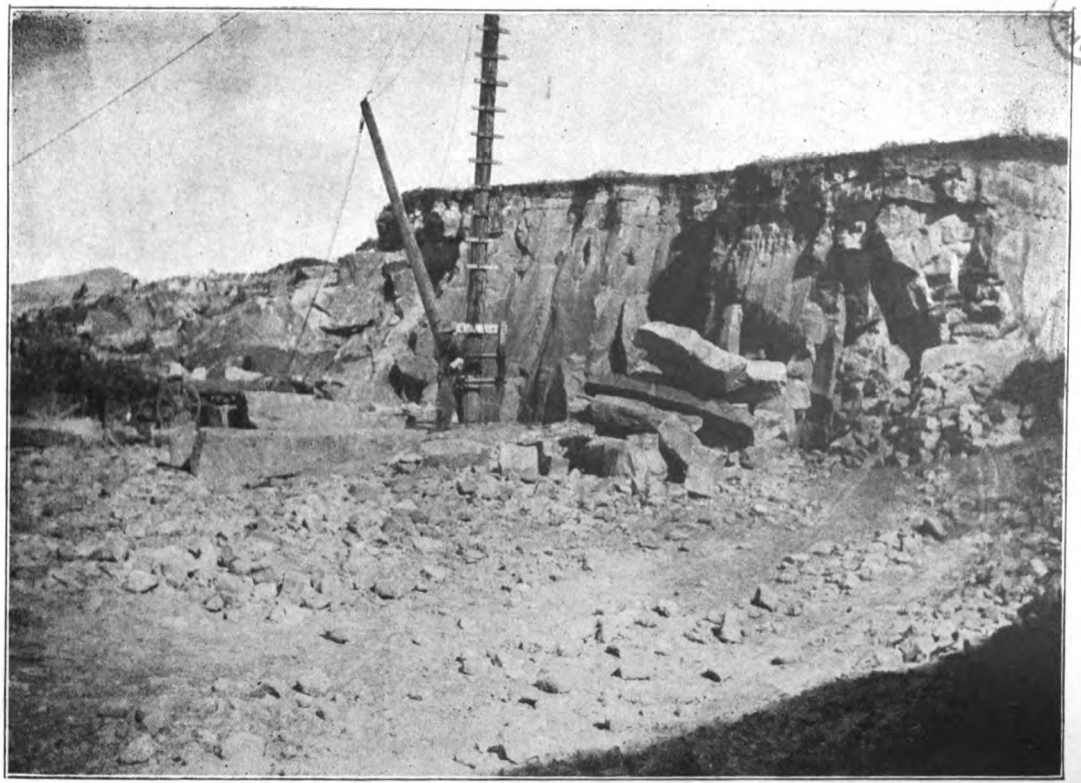
Court House at Big Timber, Built from Local Sandstone.



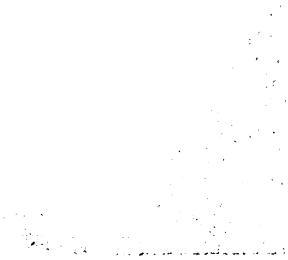
Sandstone Quarry, near Lewistown, Fergus County.

Church at Lewistown, Made of Sandstone.

PLATE XXII.



Sandstone Quarry, near Lewistown, Fergus County.



place is the stone quarried to any extent. The quarry is owned by Senator W. A. Clark, and some of the products have been shipped as far as Butte for building purposes in that city. The deposit is within a few rods of the Northern Pacific Railroad, covers a large area, and is over one hundred feet thick. It has a fairly high crushing power, is fine grained, rather light brown in color, and is fairl yeasy to quarry. This stone will probably never be widely known, as it has no marked properties, but it will have a local demand and will furnish a substantial building material for some time to come.

CASCADE COUNTY

Cascade County is also an area well supplied with natural products, having coal, limestone, gypsum and sandstone in abundance. The latter is quarried to a considerable extent near Great Falls, and is used quite extensively there as a building stone. The rock found near Belt and Armington is also a good building stone, and occurs in the Cascade formation. The Great Falls stone has a light brownnish color, and is quite fine grained. The beds are not very thick, but are easily worked. Many of the quarries are near the railroad, and therefore easy of transportation. All of the sandstones used for building purposes in Cascade County belong either to the Cascade or Dakota formations.

CHOTEAU COUNTY

Little is known of the building stones of this county, but near Havre there are several good outcrops of sandstone and a few quarries already opened. The best quarry known here is shown in the cut, and is located 4 miles southwest of Havre. The rock is a good sandstone, about 50 feet thick, with good rift and joints. It is easy to quarry, and with a fairly high crushing power and fine grained, it makes a good building stone. Many of the buildings at Havre are built of this stone. Possessing no striking characteristics, it will probably have none but a local demand.

CUSTER COUNTY

Good sandstone is found a few miles from Miles City, and is used to a considerable degree in the buildings of this city. The rock is fine grained, of a brown color and easy to quarry. It probably belongs to the upper Laramie formation. There are many other places in the southern and central part of the county where good sandstone is found, but owing to there being no demand for its use no quarries have ever been opened.

Several quarries of sandstone are now in operation at Glendive, Dawson County; Forsyth, Rosebud County; Madison, Park County, Teton and Valley Counties. These quarries are of no especial importance, while the stone is a good grade of Laramie sandstone, it has only local use.

FERGUS COUNTY

This is another county well supplies with non-metallic natural products. Near the city of Lewistown, the county seat of Fergus County, there are many excellent beds of sandstone. This stone lies immediately above the Lewistown coal deposits, and probably belongs to the Dakota formation.

There are several quarries around the city, and all seem to be doing a good business. Outside of Yellowstone, Silver Bow and Lewis and Clark Counties, Fergus County is the most active and largest producer in the State. The best quarries are all near the town (about 1 1-2 miles south), and excellent wagon roads have been made to haul out the products. The stone is easily worked, easily quarried and in every other way well adapted for building purposes. Lewistown is a city of stone buildings, and some of these buildings, made from local sandstone, are especially fine. Among such are the Fergus County Bank, the Power Mercantile Company's big department store, the High School, the Methodist Church and many others. The stone sells for 50 cents per perch at the quarry or $1.00 per perch delivered. This rock is without doubt better than most of the Laramie stones. The Columbus, Yellowstone County stone, is finer and better, but other than that the Fergus County product is one of the best so far found in the State.

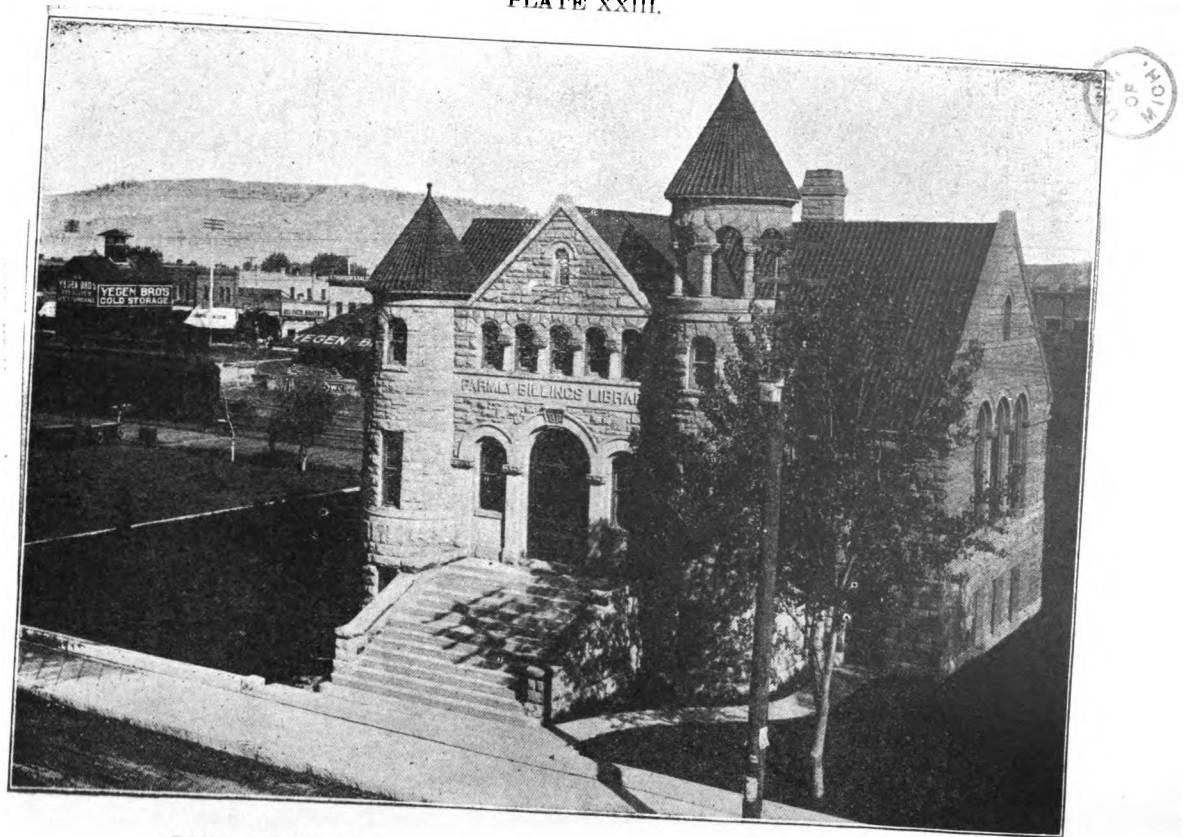
As this section of the country becomes more thickly settled, there will be more demand for quarry productc and the writer looks to see it become, within a few years, one of the principal industries of this part of Fergus County.

SWEET GRASS COUNTY

Many sandstone outcrops are found around the county seat of this county, and there are one or two quarries now in operation. The stone is similar to the Billings product, and several of the best buildings of Big Timber are built from it. Owing to its neutral properties it will probably never have a wide use.

YELLOWSTONE COUNTY

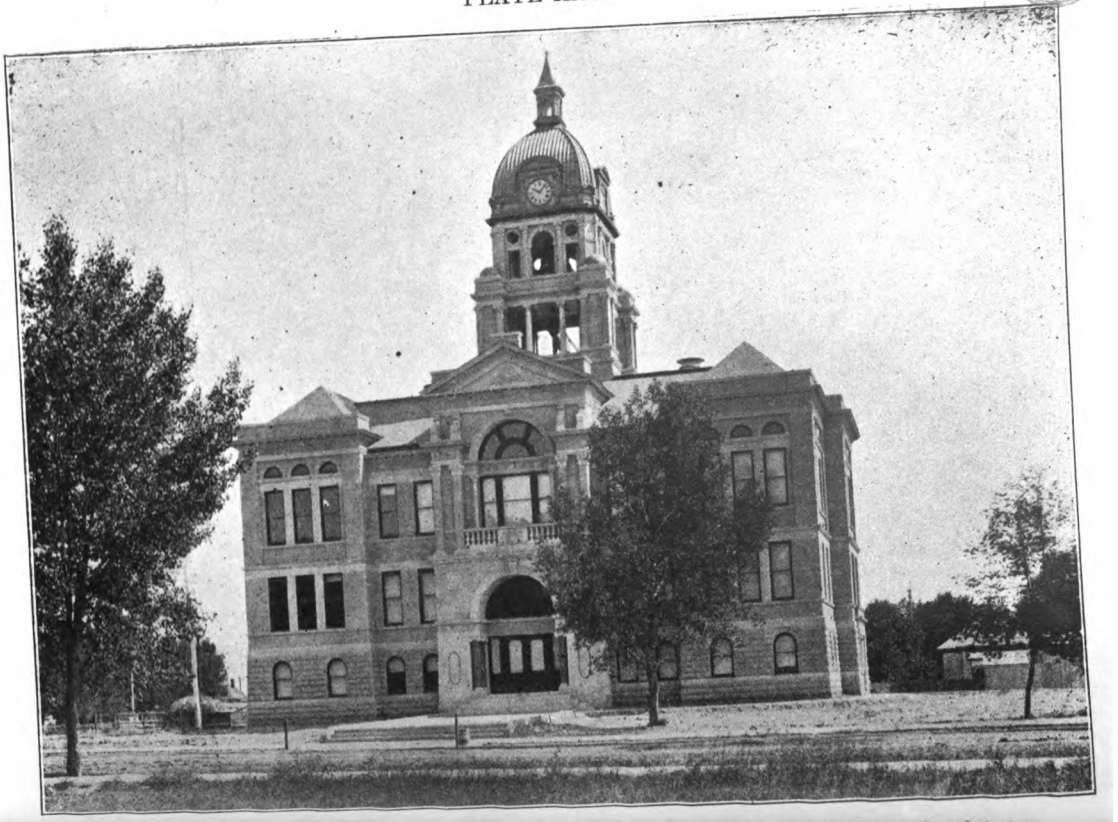
This is the banner county of Montana in the production of sandstone. There are two well developed quarries. One at Bil-



Billings Public Library, Built of Billings and Columbus Sandstones.

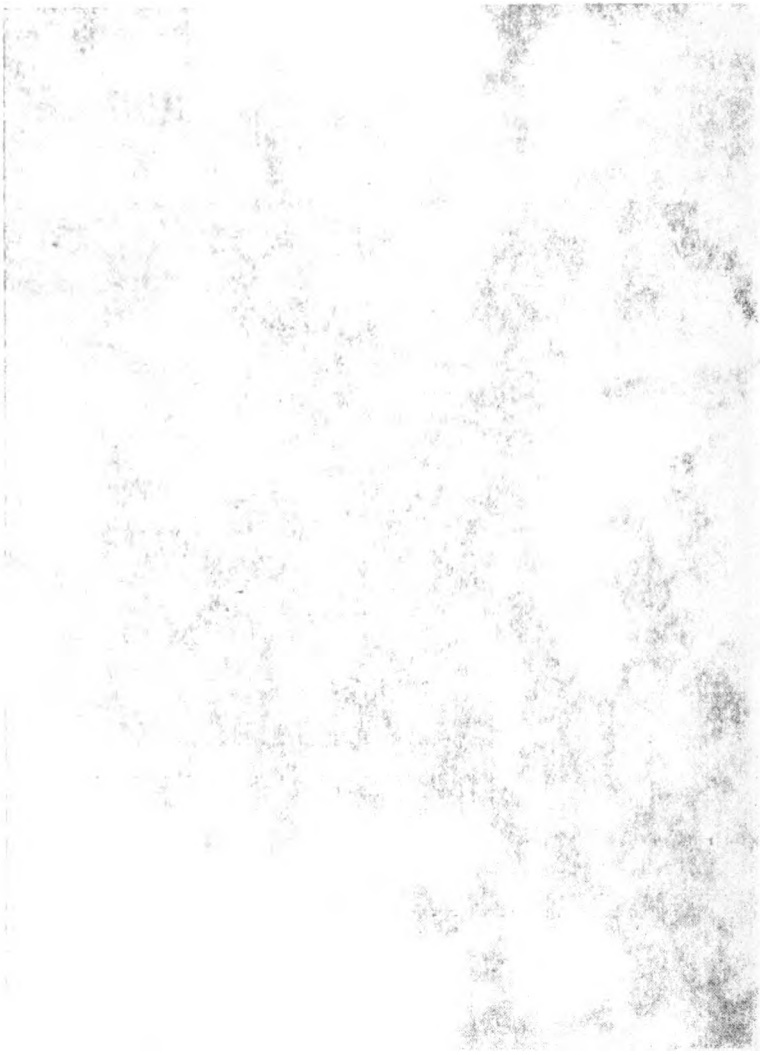
Sandstone Quarry, Columbus, Yellowstone County.

PLATE XXV.



UNIV. OF MICH.

Col. Chisholm's Onyx Quarry, near Manhattan, Gallatin County.



lings and the other at Columbus, both on the main line of the Northern Pacific Railroad. Not very extensive work is being carried on at Billings, but the bluffs north of town are capped by light, brownish colored sandstone that is rather soft when first quarried, but becomes quite hard upon exposure. Several very good buildings at Billings, including the court house, are built of this rock. It is not, however, a superior building stone. It is easily worked owing to its partially friable condition, and it weathers more readily than many of the other sandstones of the State. It is a safe stone for ordinary buildings, and all but the foundation of large buildings.

The best sandstone quarry in the State, probably both in quality and quantity of the stone quarried, is at Columbus, about 40 miles west of Billings. The stone at this place is of a bluish color, very fine grained, high crushing power, and a very even structure. It has been used in a great many buildings of the State; in fact, most of the larger ones have used more or less of this stone as a building material. The capitol at Helena is probably the best known building in the State built of this stone. It has been shipped to almost every point in Montana, however, and to many outside places, both east and west. The rock is found in Laramie formation, and does not show an extremely large deposit. It is from 10 to 20 feet thick, and owning to the splendid rift and jointing it can be quarried in almost any sized blocks. Some flagging is taken from this quarry. Grindstones are also made from this stone. It can be and is carved into ornamental rocks of various kinds.

The quarry is well supplied with the proper machinery for dressing and preparing the stone for special building purposes. Several men are employed and several thousand dollars worth of stone is quarried and placed upon the market each year. Mr. Mike Jacobs is superintendent.

The value of all sandstone products of the state would aggregate in the neighborhood of $150,000 per year.

The sandstones of the Laramie coal measures are quarried for building stone in the vicinity of Livingston and in Bridger Canyon. They are easily quarried, occuring in beds 3 to 5 feet thick, with interbedded shales, and when fresh are readily cut and dressed. They are largely used for foundation and for ornamental work in the newer buildings of Bozeman and Livingston. The grits of the Livingston beds are also quarried for building purposes. They afford a considerable range of color, and are worked near Livingston and on Boulder River for the town of Big Timber.

LIMESTONE

There are many Carboniferous and other lime stone deposits in Montana, but so far there are but three places where this rock is used for other than quick lime purposes. Col. O. P. Chilholm, of Bozeman, Gallatin County, has quite an onyx quarry near Manhattan, and the product is very similar to the Mexican variety and takes a splendid polish. This quarry is worked some, but not in a large way. The stone is good grade, and some day it will doubtless be well worked.

The ledge has been known for some time, but was only located in 1902, by Mr. Charles Logan, of Bozeman, who soon afterwards sold it to Col. Chisholm. A Bozeman company has been organized by the latter gentleman, and is known as the Montana Onyx Company. Two hundred acres of land are now owned by this company, "through all of which this ledge has been traced by outcrop for more than a mile, varying in width from 100 to 150 feet. The layers of the mineral often have a thickness of 10 feet without a joint or seam to injure the material for working in large blocks. The property is located 5 miles north of Manhattan, Gallatin County, and is easily accessible by a wagon road, which is already built."

Another locality where limestone (marble) is now quarried to some extent in the state is six miles southwest of Helena in Nelson Gulch. This quarry has been known for some time, but has never been extensively worked. It has recently been purchased by Spokane capitalists, and a considerable quantity of the stone is expected to soon be placed on the market. It is claimed that seven distinct varieties of marble are found at this place. "The different kinds are three different grades of Creoles, Sinias and Egyptian blacks and creams; a vast body of white statuary marble of great value; another of corrara marble, used for statuary and monumental purposes; and also very valuable and great quantities of blue marble used for building. There is also a large deposit or Georgia white marble, principally used for decorative purposes.

As to the amount contained in the 20 claims owned by the company it is impossible to estimate. It is known that there is a solid deposit 1,320 feet in length, and the promoters are confident that they will be able to work nearly the whole of the 465 acres embraced in the claims."

This marble quarry is close to transportation facilities, being about two miles from the Rimini line of the Northern Pacific Railroad. Mr. Foster is superintendent of this quarry, and at present but six men are working.

The third quarry is located at Dempsey Creek, Powell County.

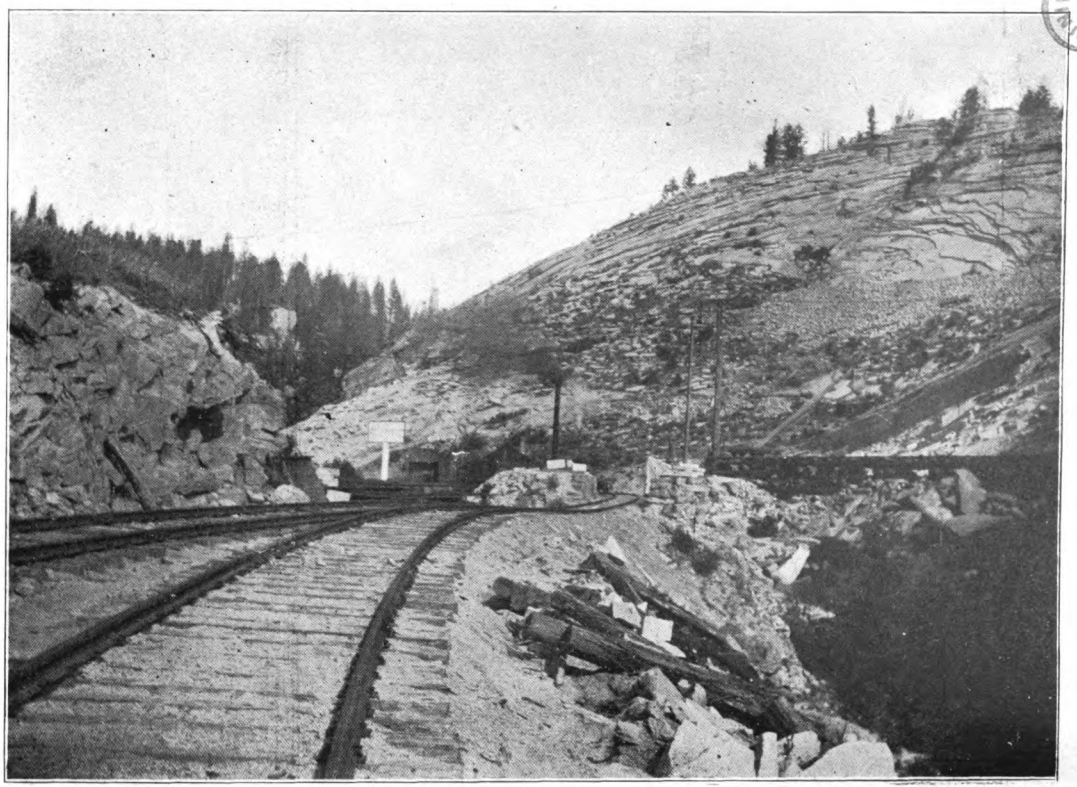
*U. S. G. S. Livingston Folio.

Kain & Sons' Granite Quarry, near Helena, Lewis and Clark County.

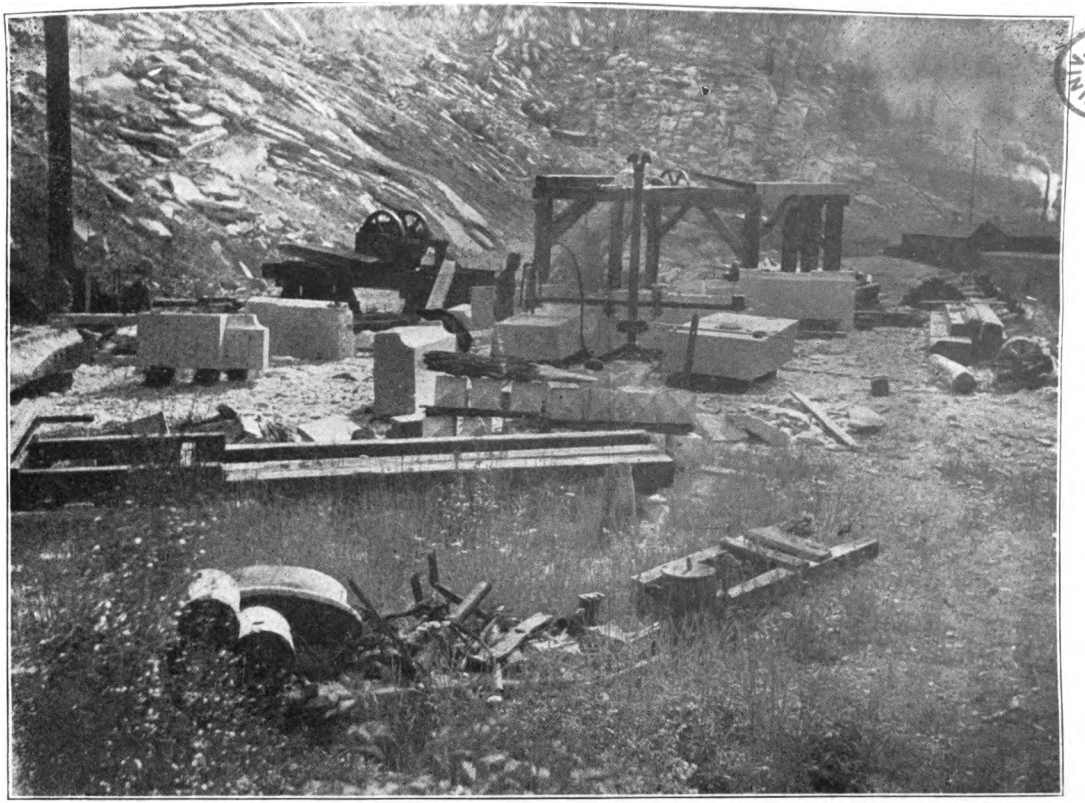
UNIV. OF WASH.

Kain & Sons' Granite Quarry, near Helena, Lewis and Clark County.

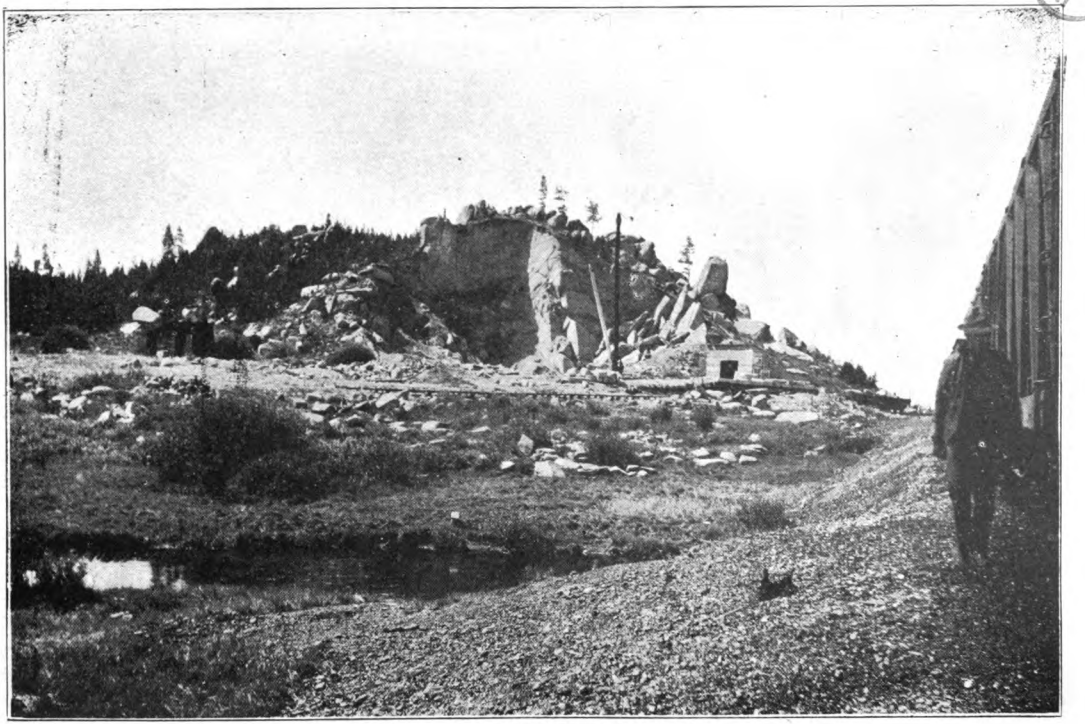
PLATE XXIX.



Granite Quarry, Welch's Spur, Silverbow County.



Granite Quarry, Welch's Spur, Silverbow County.



Granite Quarry, Elk Park, Silverbow County.

Only a small amount of development work has been done at this place. The stone, however, is claimed to be of good quality

GRANITE

Granite is found in most of the counties west of and including the Rocky Mountains, Silver Bow, Jefferson and Lewis and Clark Counties are the chief producers of this rock at present.

Jefferson County has developed some fairly good quarries of granite, but the one yielding more than any of the others is found at Elk Park. This quarry is within a few yards of the Great Northern Railroad, and turns out quite a large quantity of stone each year. The granite is a good variety, being uniform in structure and quite fine grained. Mr. Andrew Ulsher manages the property, and employs from 10 to 25 men. It is located but a few miles from the city of Butte.

Lewis and Clark County is probably the largest producer of granite in the state. There are several quarries near Helena, the county seat, but the one best known and most active at present is located about nine miles south and west of Helena, near the Rimini branch of the Northern Pacific Railroad. This is a splendid quarry and is owned by J. Kain & Sons. The rock has been used in almost every section of the State, and the only defect in its make-up is that a number of small concretionary granite nodules are found throughout the entire ledge. These nodules are usually finer grained than the main rock and of a darker color. The rock does not polish well and looks far better by chip working than either sawed or polished. None of this stone is shipped out side of the state. From 6 to 10 men are employed at the quarry.

Silver Bow County has several quarries, most of them being located on the main divide of the Rocky Mountains. The quarries near Homestake are probably the best producers. The stone is a fairly good variety of granite and is used quite extensively in the large buildings of Butte. The largest granite quarry near Butte is located at Welch's Spur, 17 miles east of Butte. The quarry is located on a spur of the main line and 1 1-2 miles from Welch's station. The granite is fairly coarse grained, however, not too coarse. The rock is black and white and does not polish well. The nodules that are found in this rock, as well as that near Helena, are much darker than the granite proper, and very fine grained.

The mass of granite forms a sort of dome, or antecline, from a side view, and breaks off, when quarried, similar to the concentric decomposition of a granite boulder.

The working of this property is quite extensive, for Montana. The drilling and dressing and loading is done largely by

using compressed air as the power. The air is compressed on the grounds by means of steam power and has a working pressure of from 90 to 95 pounds to the square inch at the quarry.

The general working force is as follows: One compressed air stone dresser, 3 hand dressers, 2 quarry men, 1 stoker, 1 blacksmith, 1 engineer, 1 crane tender, and 1 compressor tender.

The granite on the sides of Blodgette Canyon, Ravalli County, a few miles north and west of Hamilton, is probably the best and largest amount found in Montana. The mountains are literally made of this stone. Some is very fine grained, salt and pepper granite and of an even structure. Other ledges are coarser, bordernig on a reddish tinge. All of the rock of this section has a high crushing power and will undoubtedly make a good building stone. It is about five miles from a railroad and all down grade.

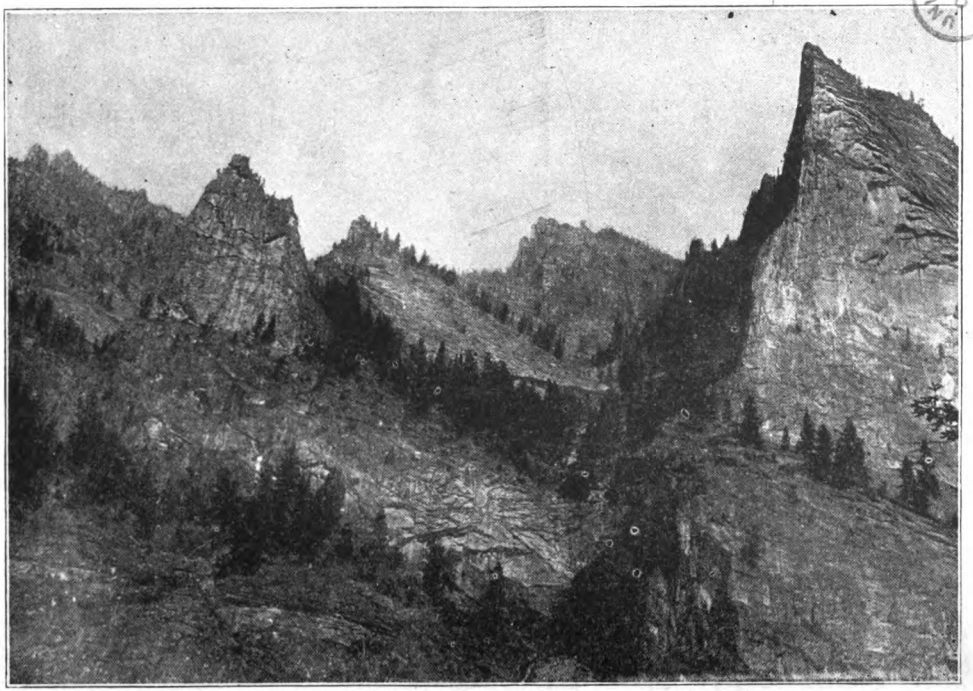
The value of the granite quarried in Montana during the past year will nearly reach $50,000.

QUARTZITE.

Quartzite is found in many of the mountain counties, and makes an exxcellent building stone, especially when the colors are pronounced and enough of one kind of stone is found for building purposes. Beaverhead County has probably the finest colored quartzite in the State, and Missoula County undoubtedly has the largest quantity. This stone, owing to its poor rift and jointing is not much quarried, but the boulders are used largely in these two counties for retaining walls and foundations. Having pronounced colors, a high curshing power, and little acted upon by meteoric agents it is eminently fitted for building purposes.

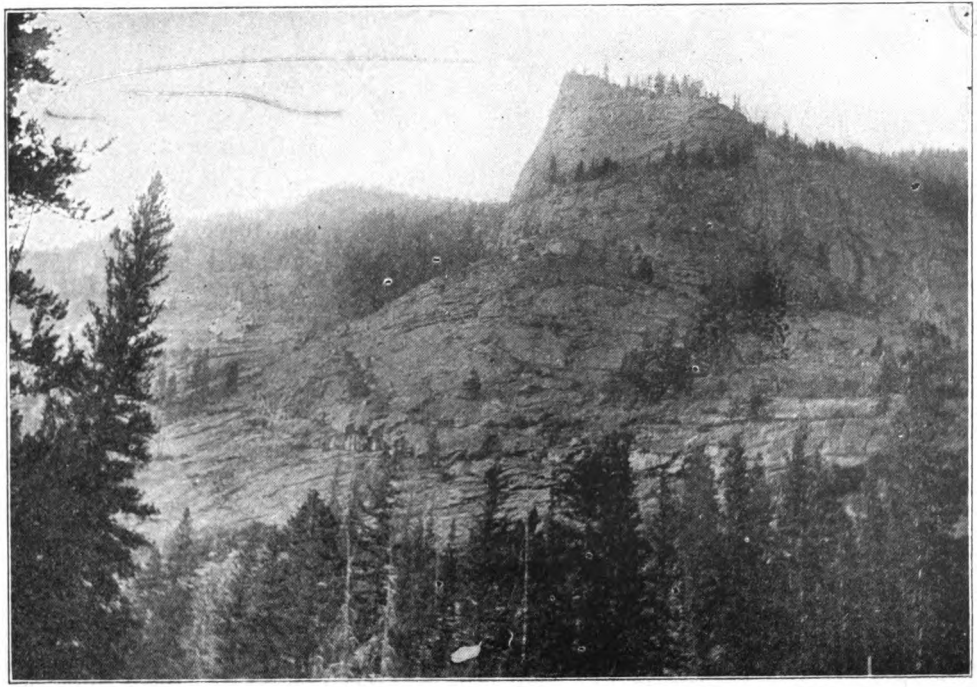
The Dillon, Beaverhead County, quartzite is found about five miles from the town and is known as the Rattlesnake or Resevoir region. The stone has a beautiful deep red to pinkish color and is used in Dillon and in Butte for building purposes. The latest large buildings in Butte, using this stone is the D. J. Hennessy $30,000 residence on Excelsior avenue; and the handsome residence of Attorney C. F. Kelly on West Park. The retaining wall and foundation of these houses, running 6 or 8 feet above ground are built of this nicely colored, well- chosen rock. The beautiful home of Attorney Orve Evans on Excelsior Avenue, Butte, is entirely built of this Dillon quartzite. No other stone in Montana is as beautiful, if well chosen, or as durable as the Montana quartzite rock.

The Missoula quartzite is found almost everywhere around the northern edges of Missoula Valley. In some locations the colors are quite pronounced, but no systematic quarrying has



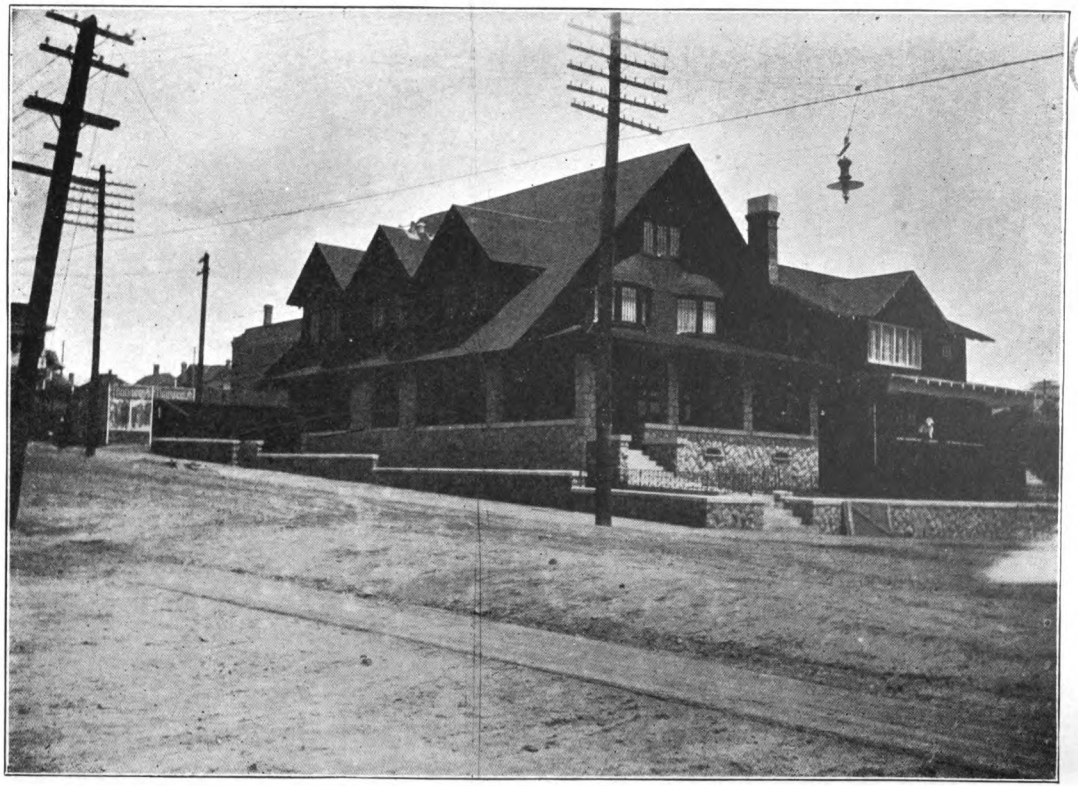
Granite Needles, Blodgett Canyon, Ravalli County.

PLATE XXXIII.



Granite Domes, Blodgett Canyon, Ravalli County.

PLATE XXXIV.



UNIV. OF MICH.

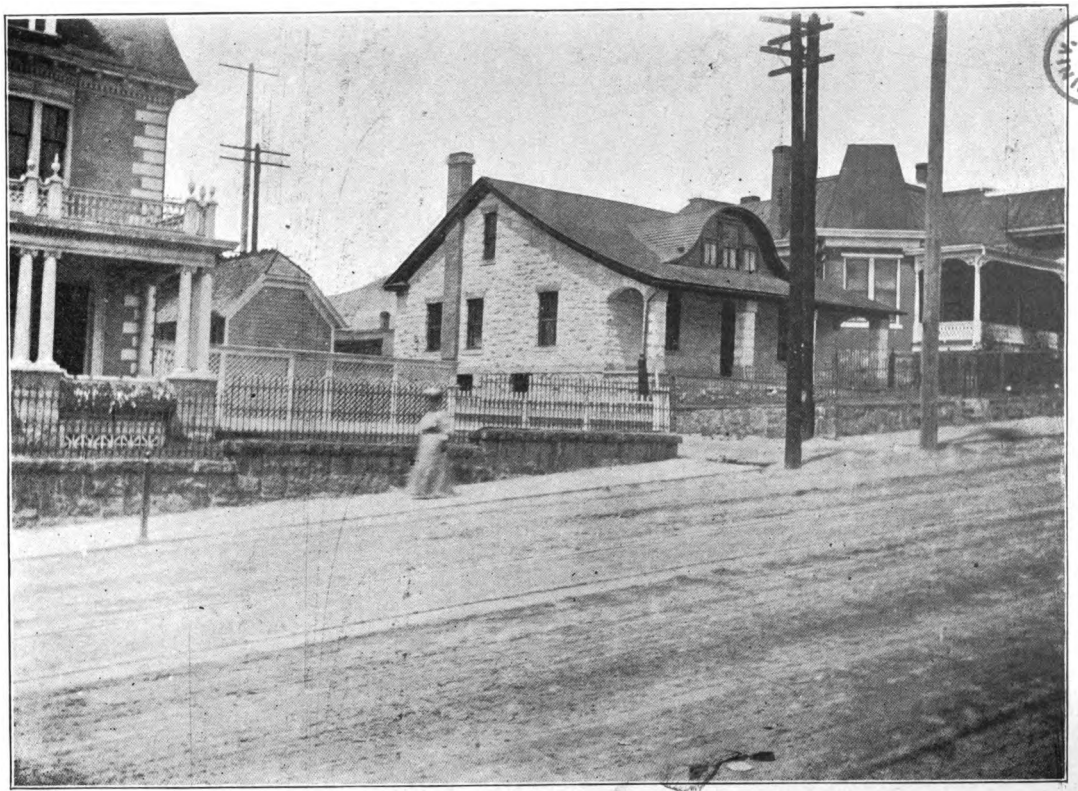
The Orve Evans Residence, Butte, Made from Dillon Quartzite.

PLATE XXXV.

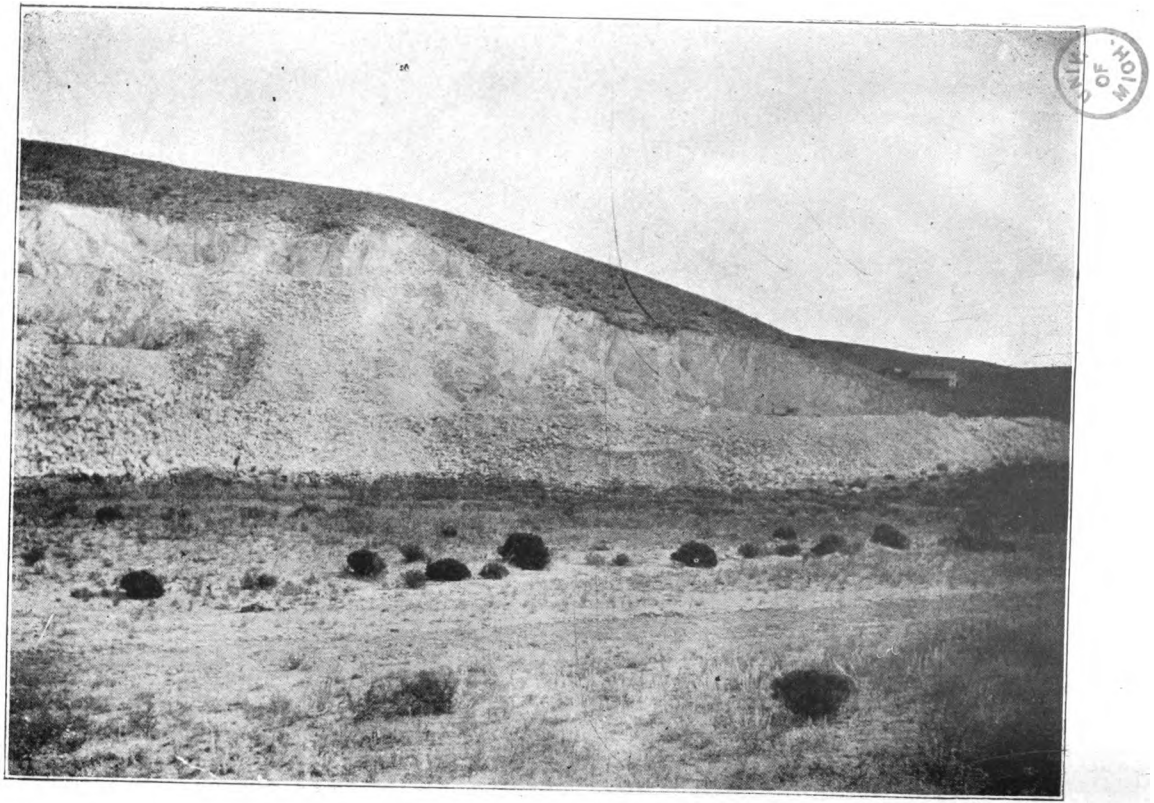
UNIV. OF MICH.

Volcanic Ash Deposit, near Forsythe, Rosebud County.

Volcanic Ash Quarry, Frying Pan Basin, Beaverhead County.



The Hight Residence, Butte, Built from Dillon Volcanic Ash Rock.



Volcanic Ash Quarry, Frying Pan Basin, Beaverhead County.

ever been done. Most of the houses in the City of Missoula have their foundations made of quartzite, but the stone is hauled, in the shape of boulders, from Rattlesnake Creek, Pattee Canyon and near the Maclay ranch, a few miles from town. The rock occurs in large ledges and probably belongs to the pre-Cambrian formation. These deposits will some day be put to good use.

VOLCANIC ASH

This rock is found in many counties of Montana, but only a few places in the State are the beds coherent enough for building purposes. The rock is a beautiful whiteish color, usually very fine grained an din some localities quite solid. Beaverhead, Gallaitin, Rosebud, Missoula, and Ravalli Counties are the chief producers of this rock in the State. About nine miles northwest of Dillon, Beaverhead County, in the Frying Pan Basin, is located the best volcanic ash building stone in Montana. The bed is from 30 to 50 feet thick and is found on either side of the wagon road running through the basin. The lower portion of the main quarry is composed of soft, white, rather friable ash, while up the creek a hundred or more feet the rock is a quite hard, cream colored rhyolite. Many buildings in Dillon are built of this rock, such as the city library and many private residences; the upper foundation, 6 to 8 feet above the surface of the Normal dormitories; lower story of the County High School; trimmings and arches of the new public school buildings are other buildings partially built from this stone. Mr. Hight"s cottage on Excelsior Avenue, Butte, and a few others, some two stories, on the West Side, are good illustrations. The rock does not weather readily, and is very easily quarried and worked. If non-staining mortar is used it keeps its color well and makes a pretty looking building. It will never be used, however, for the main walls of large buildings.

There are some large deposits in the Bitter Root Valley, near Victor and Stevensville, that are quite coherent, and will be given a trial as a building stone during the coming summer.

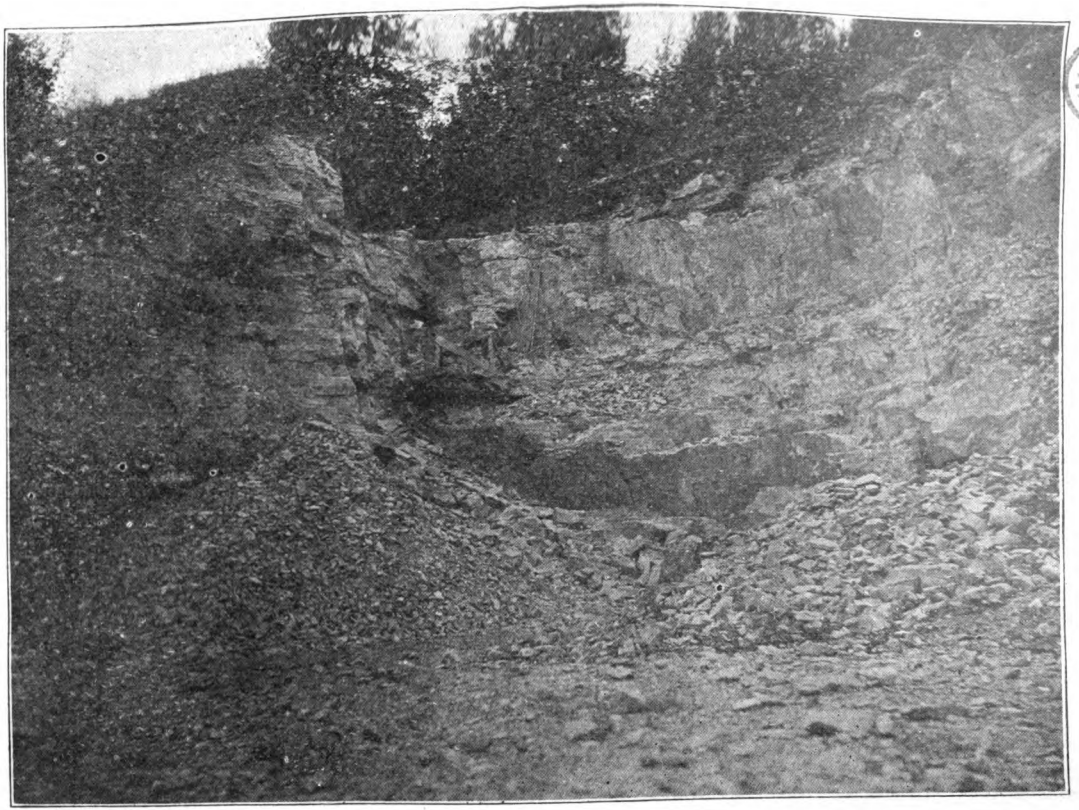
PHYLLITE OR SILICIOUS SLATE

This kind of rock is found in many of the mountain counties of Montana, but its use is very limited. At Kalispell, Flathead County, is found the best quarry of phyllite known in the State. The rock is quite hard and flinty, and makes a splendid building stone. It has almost a typical slate color, very finely lamminated, and is not readily acted upon by the atmospheric agencies. The quarry most developed is two miles south and west of town. Several of the larger buildings of Kalispell are wholly or partially

made of this rock; such as the court house, school buildings, etc. The rock has not a uniform color, being more or less streaked, and owing to this fact, regardless of the large deposits found around Kalispell, it will probably never have a wide use.

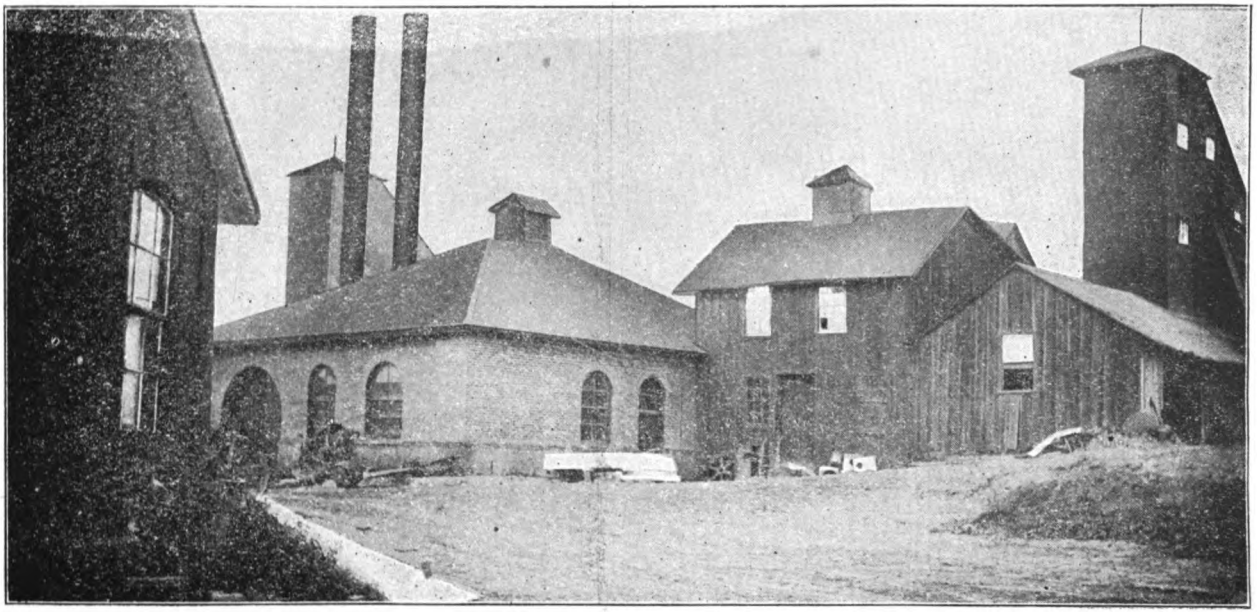
In the Hell Gate Canyon, near Missoula, is found a silicious slate that has been used somewhat for lower foundation work. Its crushing power is much lower than that at Kalispell, and in many ways it is not nearly so good a stone. It is easily worked for rough walls, but has not a wide use. The new $40,000 City school building at Missoula has its sub-foundation made of tihs rock. The surface foundation and up about 6 or 8 feet is made of the Missoula quartzite.

Enough has been written to show the extent and quality of the Montana building stones. Time alone will place this industry where it belongs, in the front ranks of non-metallic economic products of the State.



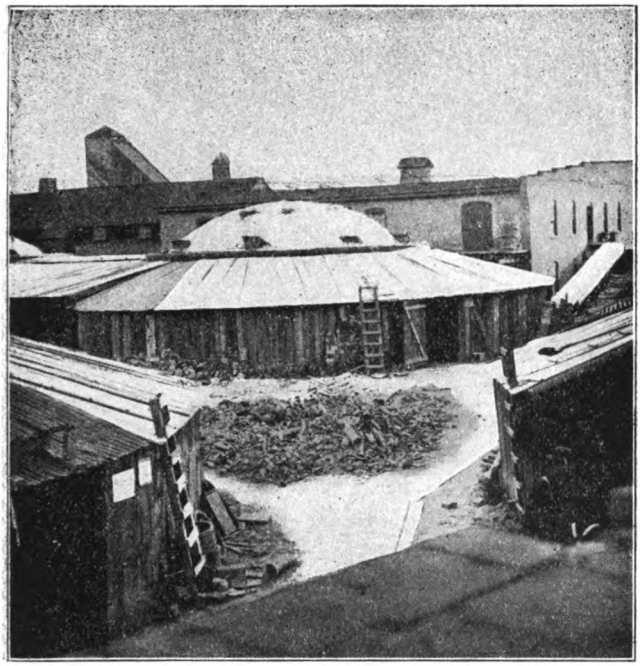
Phyllite Quarry, near Kalispell, Flathead County.

PLATE XL.

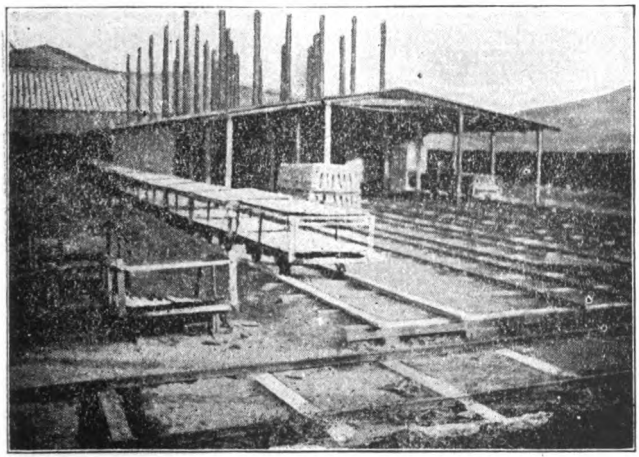


The Western Clay Manufacturing Co., Helena, Montana.

PLATE XLI.



Western Clay Manufacturing Co, Helena, Montana.



Drying Building, Western Clay Manufacturing Co.

UNIV. OF MICH.

Montana Clay Industry

Little has ever been written concerning the clay products of Montana, not for the reason of the scarcity of clay, nor the scarcity of its products, but for the reason of the absorbing interest in the gold, silver and copper mining industries. The State is abundantly supplied with good brick and pottery clay, and almost every town within its borders has its brick kiln—some two, and some even more, thus supplying the local demands and in several cases shipping out a few carloads each year. The industry is new, and some of the best clay beds are yet totally undeveloped. In a state of such magnitude and such varied mineral resources it is quite natural for the gold, silver and copper resources to be greatly developed to the detriment of the development of the lesser natural products. However, the time will come, and not long distant, when such products as clays, building stones, limes, gypsums, etc., of the State will be sought after, and good use made of all the vast deposits now lying idle.

During the past five years the writer has visited every county and town and almost every community in the State. And it is very gratifying to be able to report the existence of large beds of pottery clay in almost all of the valleys beginning with the eastern part of the Rocky Mountains and west. The eastern plains portion of the state has good common brick clay, but so far as the writer knows no pottery clay has been found in the plains section of the country. Then, most of the good clays, pottery clay, etc., are found in the mountain valleys, and for the most part are of glacial origin, i. e., the beds were deposited in the glacial lakes from the glacial rivers which flowed into these lakes, these rivers being highly charged with rock flour, such rock flour being due to the grinding together of the rocks caused by the movements of

the glaciers. Nearly all of the pottery clay deposits are finely laminated and some are thinly interstratified with silica. The interstratification of silica, however, does not hinder the clay from making a most excellent pottery.

Such deposits are quite abundant throughout the western third of the state, and are from 1 to 20 feet thick. Such valleys as the Missoula Valley, Bitter Root Valley, Kalispell Valley, the valley near Thompson Falls and Plains, and many other like valleys have one or more good clay deposits in each.

At many of these places pottery plants are now in operation and others are on the eve of opening.

There will be a time when Montana will build all her buildings, whether public or private, large or small, from Montana wood, brick or building stone; to finish and plaster their walls with lime and stucco taken from her own quarries and calcined in her own ovens; and to heat these buildings with coal and briquetted lignite dug from her own mines. It will take time to fulfill this idea, but it is bound to come.

A short discussion will now be given upon the more important brick and pottery plants in each county.

LEWIS AND CLARK COUNTY.

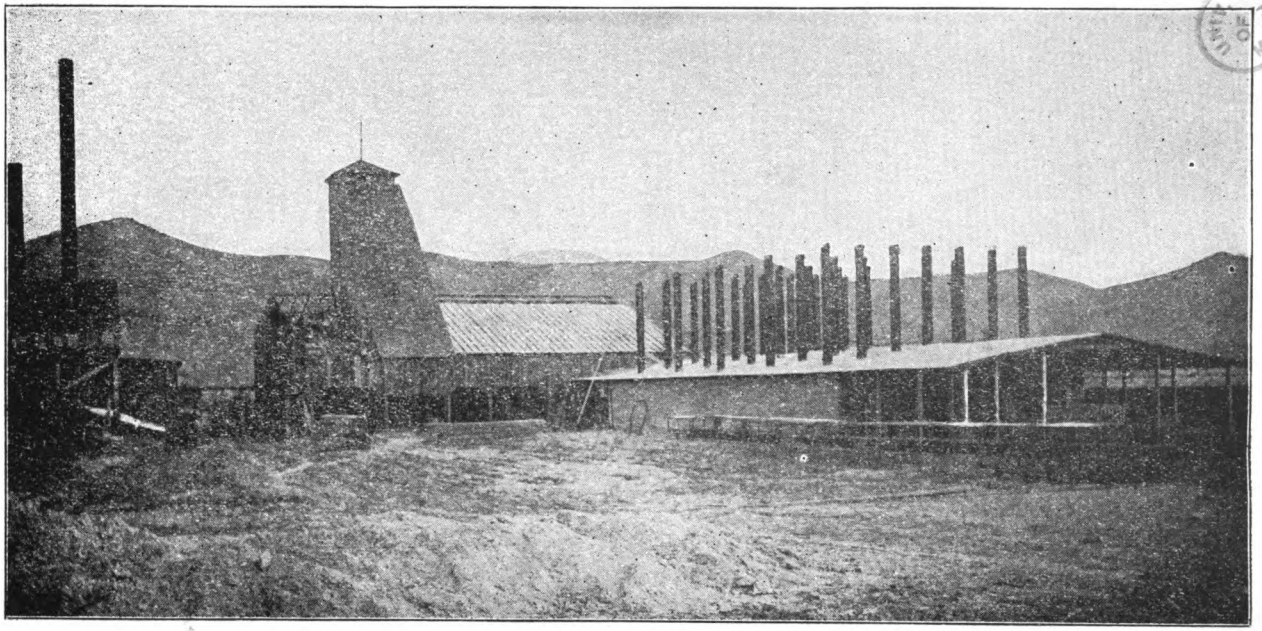
The main plant of this county is located at Helena. It is without doubt the most complete plant in the State, especially as to the number of products turned out from its kilns. It is practically the only plant in the state that turns out any quantity of sewer pipes, large lawn vases and other porous terra cotta work. It is known as the Western Clay Manufacturing Company.

The Western Clay Manufacturing Company.

The Western Clay Manufacturing Company, situated in the capital of Montana, the beautiful city of Helena, is doubtless one of the best plants in the northwest. The city of Helena, with a population of about 20,000, has the main line of the Northern Pacific, and a branch line of the Great Northern, railroads passing through it. By this means the clay products manufactured in Helena, of whatever kind, have direct transportation facilities to all of the larger towns within the State, and also to towns of neighboring states.

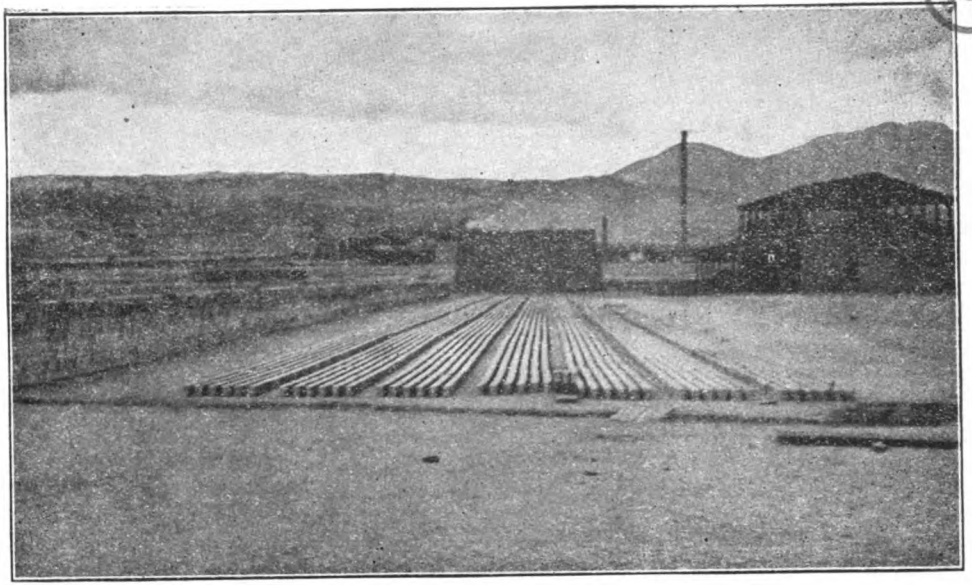
The Western Clay Manufacturing Company's plant is situated about two miles from the main part of the town, and is connected with two railroads by means of a switch. running directly to the main works. This company is the successor of the Kess-

PLATE XLII.



Western Clay Manufacturing Co., Helena, Mont.

PLATE XLIII.



Lower Yard, Butte, Montana.

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ler Brick and Pavement Company, having changed hands December 1, 1905.

Mr. C. H. Bray, a well known clay worker of the northwest, and former superintendent of the Kessler Company, is now secretary and general manager of the new company. This company owns 40 acres of splendid botto mland, where the main works are located, and 280 acres of good land near Blossburg. a few miles west of Helena. There are several buildings now erected at the plant, including the sewer pipe shop, 70x192 feet; a press building, 65x75 feet; driers, kilns, office and two or three other commodious buildings now in process of construction.

The clay for all the common brick is gotten in Helena. Some from the flat near the plant and from Lawrence street. The remainder from ground up shale. By far the larger amount and better quality of clay, however, is gotten from Blossburg. The clay at this place is a good quality of pottery clay, ranging from blue to almost white in color, and being about 75 feet in depth. The clay at Blossburg is dug and loaded into bottom automatic dump cars of three tons capacity each and run from the clay pit to the shipping cars by means of a private tramway. The clay deposit, near Blossburg, is only a short distance from the main line of the Northern Pacific Railroad, and is connected to the latter by a spur. The clay is shipped to the Helena plant, where it is stored in a store shed 60x80 feet and 30 feet high.

The machinery used for preparing the material consists of dry and wet pans for the sewer pipe and dry pans for the dry pressed work. One Stevenson dry pan, size 9, and one American dry pan, size 8, are used. The clay is tempered by means of Pug-mills. One American and three Wellington Pug-mills are used, all horizontal. The clay is ground by a Blake crusher. Water is used in the Pug-mill for ordinary brick; sawdust for fire-proofing material; and grog for the various other products. The clay is molded from soft mud, stiff mud and dry clay. There is only one stationary and one shaking screen, size 3x16 feet.

The clay is conveyed from the dry pans to the press by means of a cup elevator, and from the wet pans to the sewer pipe press by means of a belt conveyor.

The molding machines used in this plant are for the soft mud; two Quaker and two Monark machines of a daily capacity of 30 M.; and stiff mud machines, one Giant, daily caapcity 35 M., and one Acme, daily capacity of 20 M.

The drier connected with this plant is worthy of special mention, and is the most up-to-date and best in the Northwest. It is not so spacious as many, but otherwise it is A No. 1. The drier built of brick with seven car tracks and compartments and a total capacity of 40M. The American Clay Machinery Company

drier cars are used, and the drier is heated by means of steam passing through a series of steam coils placed between the rails. The time necessary for drying is about 24 hours. For burning the clay products there are five over down-draft kilns and the Clamp kiln for the common brick. with a capacity of 300M to 1,000M. The method of setting is 3 on 3 by 40 bricks high.

The fuel for water smoking and the common brick kilns is wood, while the fuel for the round kilns is coal, from the mines at Bridger and Red Lodge, Carbon County, Montana.

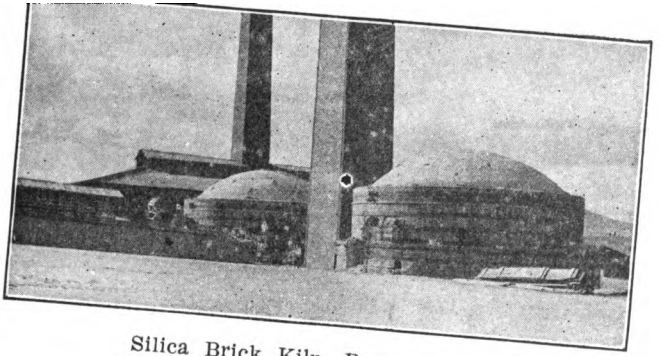
The plant has two engines, one for the general plant, a Corliss 250-horsepower engine; and the other, used in the machine shop, a 20-horsepower. The products of this plant are the most varied of any plant in Montana. The most products now being turned out by this company are as follows: Fire proofing flue lining, fire clay tile, fire brick, flower pots, lawn vases, vitrified culvert and sewer pipes, vitrified sidewalk and paving brick, white and red pressed and ornamental brick, besides the ordinary "common" brick.

This plant was started by Mr. Kessler some time in the early seventies as a hand-molding plant, and in 1885 a 15-horsepower engine and other machinery were introduced. Since December 1, 1905, many changes have been made, and much new machinery added. The plant is making rapid progress, and under the able management of Mr. C. H. Bray, it will undoubtedly be a splendid dividend payer. The products from the Western Clay Manufacturing Company's plant are in good demand, some being shipped to Spokane, Washington, and also into towns of Idaho and Wyoming and all parts of Montana. The Federal building at Butte, Montana, was partially built from the products of this company, the roofing tile, fire-proofing and pressed brick; and the same of the Helena Federal building, with the exception of the roofing tile. The streets of Helena were paved nearly two years ago from the vitrified paving bricks made by this company, and the paving is as good now as when first laid. Great Falls is to pave her streets with bricks from this company's kilns.

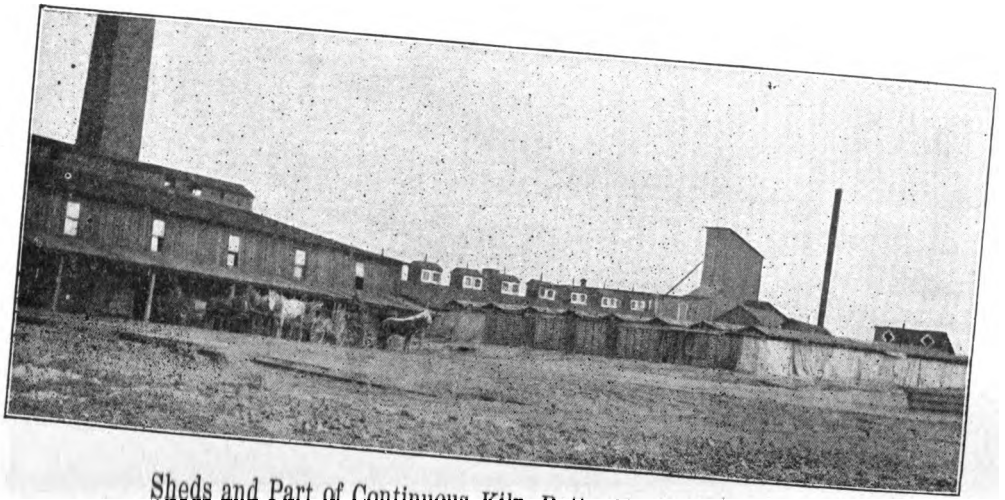
The plant is now valued at $60,000. The output of common bricks per annum is between 2,000,000 and 8,000,000. There are about 50 men employed, with salaries ranging from $2.75 to $4.00 per day, averaging about 10 months as the working season.

Taking it all in all this is a splendid plant, and improving each year. It is conducted as a business enterprise by business men, and managed by an up-to-date and practical clay worker.

There is a very good bed of fire clay two miles from Helena known as the John Quirk mine. Above Rimini there is also a large deposit of fire clay.

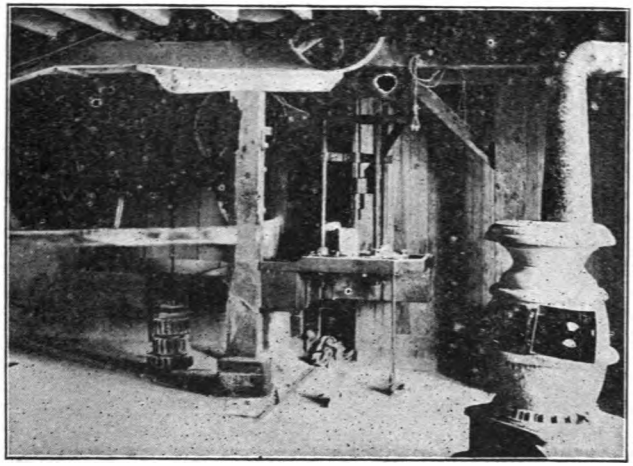


Silica Brick Kiln, Butte, Montana.

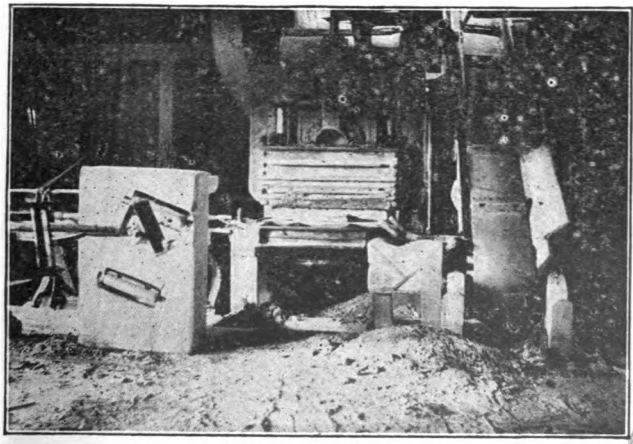


Sheds and Part of Continuous Kiln, Butte, Montana.

PLATE XLV.



Crucible Mould, Butte.



Common Brick Moulds, Butte, Montana.

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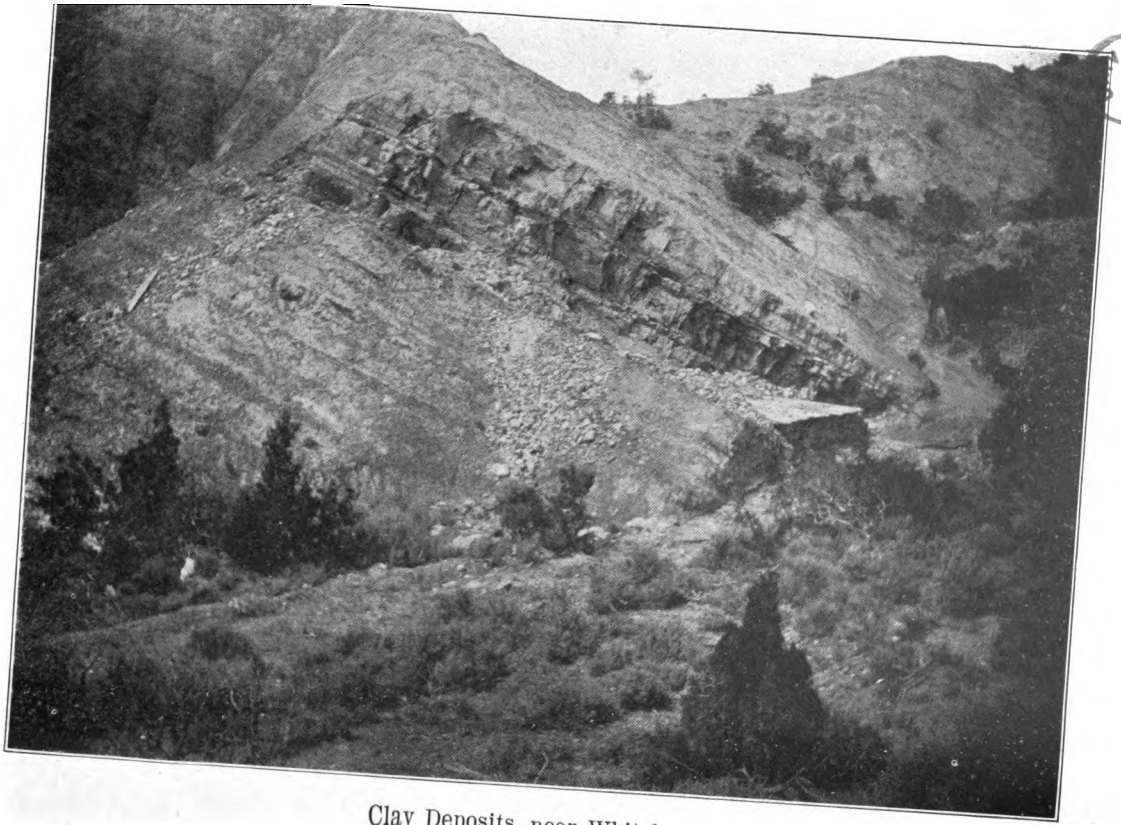

Clay Deposits, near Whitehall.

SILVER BOW COUNTY.

The county of Silver Bow has one of the best plants in the state. This plant is the Butte Sewer Pipe & Tile Company, of Butte, Montana.

The Butte Sewer Pipe and Tile Company, located at Butte, Montana, is one of the best plants of its kind in the northwest. It is owned and operated by Mr. J. G. Hammer & Brother, and is situated in a most ideal location for the manufacturing and transportation of its products. Four railroads, the Great Northern, the Northern Pacific, the Oregon Short Line, and the Butte, Anaconda & Pacific run into Butte. Soon the fifth, the Chicago, Milwaukee & St. Paul will pass through. All of these roads are easily accessible to this plant. A spur from the Northern Pacific connects this property with the main line of this road, and as all of the roads have switch connections either in Butte or near, cars loaded at the yard can be shipped directly over any of the roads. Being located at Butte, it makes it possible to ship the clay wares east, west, north and south with the minimum amount of distance.

The grounds are nearly level, having a slight drainage to the north into Silver Bow Creek. Two hundred acres of land is owned by the company at Butte, including the lower and the upper yards and the common clay bank. The plant includes a machinery building, packing house. office, store house, blacksmith shop, boarding and lunch house, drying building and shads, a continuous kiln building, and many others of importance. Most of these are built of brick. The common brick clay is obtained near the plant, while the fire clay is gotten from Whitehall, a distance of 35 miles from Butte. This latter is over 10 feet thick and of a good variety. It is hauled to the railroad by teams and shipped by freight over the Northern Pacific Railroad to the plant in Butte. The mining is done the same as ore, but only the simplest methods and machinery are used. The clay is not weathered before using. It is not stored, but shoveled from the cars to the ground and remains there until used.

The material is prepared for the fire bricks by means of the dry pans and Gates crusher. The clay is tempered by three horizontal pug-mills. Grog is used in the fire bricks. Water is used in the pug-mills. The clay for the common brick is dumped in the pug-mill and mixed with water to a soft mud and then run into hand molds, one Quaker and one Potts, and sanded by means of a belt conveyor. Each molding machine is attended by one sander, one cut-off man, one stacker and two carriers. The plant has several kinds of molds, such as cornice molds, freize molds, corner molds, etc.

The number and kinds of kilns in this plant are as follows: Two beehive kilns for fire brick; one kiln for assay products; one kiln for bone ash; one continuous kiln, and one ordinary kiln in the lower yard for common brick. The only continuous kiln in Montana is found here. There are 14 kilns or compartments in the continuous kiln, with 35 fire or feed holes. Twelve of these kilns hold 30,000 each, and the other two 43,000 each. After the bricks are placed in the kiln it takes about 10 days from the time the kiln is sealed until the burned bricks can be taken out. Three days to water smoke, three days to burn and four days to cool. The initial expense is larger in making a kiln of this sort, but money is saved in the long run on fuel and men to run it, as one man at a time is needed to fire the kiln. Mr. William Radford has charge of the continuous kiln, and about 4,500,000 are turned out from this kiln annually.

The lower yard with an ordinary kiln burns between 15,000 and 16,000 at each burning, and it takes from 10 to 12 days to burn them. Coal is used in all of the kilns and in the engines. Between 350,000 and 500,000 are the number turned out from the lower yard. None but the simplest methods of molding, sun-drying and burning are used. The time for burning the fire brick is 48 hours.

The method of setting the brick in the kiln is 5 on 5 and 25 bricks high.

The power for running most of the machinery is electricity. The common building bricks are only made in the summer, but the fire bricks and assay goods are made the year around.

The products turned out by this plant are quite numerous. Chief among them, however, are the common building bricks, the fire or silica bricks and the assay goods, such as crucibles, cupels, scorifiers, muffles, etc. These are made from splendid material and furnish the many assay laboratories of Butte with first-class, fresh material with which to work.

This plant has no difficulty in getting orders for their products. The main trouble is to supply all the demands. Not only Montana, but many of the other neighboring states use the brick and tile of this company for their building purposes.

The company was organized in 1889, and at that time only common bricks were made. Six years ago the fire brick and assay departments were added, and they have done a splendid business ever since.

At present there is over $100,000 invested in the business, and improvements are being added each year. Fifty men are employed, receiving wages ranging from $3 to $4.50 per day. The total output of common brick is between 5,000,000 and 6,000,000 per annum. These are shipped to all parts of Montana, and some to outside states. Many of the large buildings of Butte, Anaconda, Dillon, Livingston and other eastern State towns are

built wholly or in part from the products of this plant. The assay goods find a good sale in many towns in the state outside of Butte. The fire brick find their way as far west as Seattle, and in many towns of Southern Canada.

The plant has an excellent location, turns out splendid material and is managed by a shrewd, practical business man, Mr. J. G. Hammer. With the present great prosperity of the country, there is much new blood coming to the west, and in Montana building has probably never been so active. This calls for building materials. Lumber has gone up 50 per cent within a very short time. Larger cities are requiring fireproof buildings. There is, therefore, becoming a greater demand for brick and stone for building purposes, at present those of a special quality. This will doubtlessly decrease as years go by, and as Montana develops her vast clay resources.

Butte is indeed fortunate in having at her very door a clay plant with such varied products, and a man at the head of it whose end and aim is to put first-class goods upon the market.

MISSOULA COUNTY.

This county is abundantly supplied with good clay deposits. In and around Missoula Valley there are found some of the best pottery clay beds in the State. The only attempt at utilizing this natural product is a first-class brick plant about five miles from the city of Missoula, and another about one and one-half miles, both owned and operated by Mr. Hollenbeck. Between Missoula and Grass Valley, a few miles down the Missoula River from the City of Missoula, are found several exceptionally fine clay banks. The clay contains some alkali, but not in sufficient amounts to be a detriment in burning. Some of these beds are from 10 to 20 feet thick, and give good promise to the future clay industry of this valley. About five miles south and west of Missoula, near what is known as the Buckhouse bridge, is found a bed of clay that burns as well as any in Montana. The deposit covers about 200 acres, and from all indications has a uniform depth of several feet. The clay in some places is thinly laminted and has a light pinkish color. Some of this material was molded into small vases and jugs and burned at the University, and by ordinary burning a beautiful terra cotta ware was turned out. This clay will make good dry-pressed bricks, tile or sewer pipes, flower pots, and with proper glaze will make excellent vases, jardiniers and most of the ordinary earthernware. The deposits is only a few yards from the Bitter Root branch line of the Northern Pacific Railway, and is also handy to wood water.

Within the past few months a new brickyard, known as the Missoula Brick and Tile Co. has been started near Missoula. This to Bonner. The clay used is a good variety and some splendid products should come from this yard. The property is owned by a number of prominent business men of Missoula.

The common bricks made in Missoula are of a good quality. They are used in many of the larger buildings of the city, the last one being the $40,000 school building just recently finished. Nearly 1,500,000 bricks were burned last year, valued at about $10,000. Between $12,000 and $15,000 are invested in the business, and more than $5,000 is paid out annually for labor. The writer looks to see all the clay deposits in this county soon put to good use. Nearly all of the clap products used in the towns and cities of this county are shipped in from long distances with high freight rates, while they could be produced at home and probably for less cost.

CASCADE COUNTY.

The clay industry of this county is centered almost entirely at and near Great Falls. There are several banks of good clay around Great Falls, and besides using it for brick, etc., at this city, some of it is shipped to Helena, Butte, etc. There is one large brick plant at Great Falls owned by Coombs & King, and until last year it has been in active operation.

This plant has a capacity of between 30,000 and 40,000 common bricks per day. Some of its products are shipped both east and west in the northern part of the State, and the remainder used for local demands. The common building brick, the front building brick, and the silica fire brick are the kinds mostly produced. There was until recently a fire brick plant about four miles from Great Falls. At this place is found excellent fire clay. Good fire clay is also found near Armington. This is owned and operated by the A. C. M. Co., and belongs to the Kootenai formation.

The annual output of the common brick from the Great Falls plant is about 2,000,000, valued at about $15,000. There is between $30,000 and $40,000 invested in the business, paying about $10,00 per year for labor, and manufacturing products to the value of nearly $30,000.

Inasmuch as the clay is near by and the demands large, the writer looks to see a great increase in the clay products of this city within a few years.

SANDERS COUNTY.

The clay deposits of this county are undoubtedly among the most extensive and best in the State. Good pottery clay is found from Plains to White Pine. These deposits are east of the Coeur d'Alene Mountains and in the valley of the Clarks' Fork of the Columbia River. At Thompson Falls, the county seat of Sanders County, is located the only brick yard and pottery plant in this county. The clay is very good at Thompson and also at White Pine. The pottery plant at Thompson is owned by Mr. Florin, but managed by Mr. Roberts and son, practical brick workers. Several thousand good bricks have been burned during the past summer, and the finest pottery turned out in the state. The clay is similar to the Missoula Valley clay; it covers an immense area, and is several feet thick. The prospects of Mr. Florin's pottery enterprise in this valley is very promising.

DEER LODGE COUNTY.

The most important plant in this county is located at Anaconda. This plant is owned by the Amalgamated Copper Company, and in the past has been a large producer of common brick —burning about 7,000,000 in 1903, valued at about $55,000; since then they have made more silica fire brick than any other kind. turning out about 7,000 per day. Last year the plant turned out about 800,000 alumina fire bricks, valued at $35,000, and about 1,000,000 silica bricks, valued at about $53,000. The silica and fire brick plant is complete in every particular, and the clay and silica is gotten in the near vicinity—most of the fire clay, however, is shipped from the company's bed near Armington, Montana.

The company has about $50,000 invested in the plant, and pays about $85,000 per year for labor. They employ between 50 and 75 men, paying them from $2.50 to $5.00 per day. The total value of the burned products in 1904 was $139,776. The clay for the common brick is found within a few rods of the kilns.

FLATHEAD COUNTY.

Pottery clay, brick clay and fire clay are found in many places in this county. Clay similar to that found at Missoula and Thompson Falls is found near Big Fork, all around Kalispell at White Fish, etc., has an exceptionally good brickyard, and makes the best pressed bricks in the state. The common bricks are good, and some of them are shipped to outside towns. Good bricks are also made at White Fish, a small town on the

main line of the Great Northern Railway. These the only places of any importance where the vast clay deposits of this county is being used. The clay around Kalispell is a good pottery clay—some alkali is present,, but not enough to damage the products. Over 1,500,000 bricks are burned here each year, and they are valued at close to $10,000. About $12,000 is invested in the business, and over $4,000 is paid yearly for labor.

RAVALLI COUNTY.

Many clay deposits are found in this county, especially in the Bitter Root Valley. Samples have been sent to the University from Victor, Stevensville, Hamilton, Corvallis, Darby, Grantsdale, etc., and most of them show good promise. There was a brick yard at Stevensville, and there is now one at Hamilton, and both have made a good common brick. One of the largest deposits of clay in this county is found near Grantsdale, and is a good pottery clay. Steps are now being taken to start a pottery plant at this place. Mr. Roberts, manager of the Thompson Falls plant, is negotiating with the business men of Hamilton, and thinks he will be able to place the Grantsdale ware on the market some time during the coming year.

The beds from which the supply of clay will be taken are located on the Bush place, south of Grantsdale, and are extensive enough to keep a dozen potteries running an indefinite time. Their existence has been known for some time, and frequent tests, showing it to be a first-class pottery clay, have been made. It burns into a hard, durable ware, and takes an excellent glaze. It is planned to haul the clay to the factory by team, as the distance is not more than three miles, and the expense of teaming will not be large, thus placing the ware and the factory directly at a shipping point.

A white clay deposit has been reported from Blodgett Canyon, near Hamilton, which parties claim to be a first-class clay, nearly kaolinite.

ROSEBUD COUNTY.

There are two brick yards at Forsyth, the county seat of this county. The one owned by Marceys & Son employ several men and burn 500,000 bricks per year. The other yard turns out a few less, probably 300,000. Most of the large business blocks of Forsyth and many dwellings are built from the home product. Some are shipped to other nearby towns. The clay used is ordinary alluvial clay, and produces a fairly good red brick. Clay suitable for brick is found almost anywhere near Forsyth. About $6,000 or $7,000 worth of brick per year are burned at Forsyth.

More than $3,000 per annum is paid for labor, and about that amount is invested in the business.

Yellowstone County has two brick yards at Billings, and together, with the building stone near by, the city has no scarcity of building material. Between $16,000 and $20,000 represents the value of the yearly output of clay products from this county, and nearly $10,000 is paid out per year for labor.

GALLATIN COUNTY.

About 800,000 common building bricks are produced in this county annually, and nearly $3,000 paid for labor. Owing to good building stone being found in this valley the brick industry has never been pushed. Excellent pottery clay is found within one mile of Bozeman, and acres of clay good for the best pressed brieg and darin tiling is found within the immediate neighborhood.

VALLEY COUNTY.

At least two towns have brick yards in this county. These towns being Glasgow, its county seat, and Malta, both on the main line of the Great Northern Railroad. The clay is entirely of alluvail origin. About 700,000 bricks are produced in this county per year, valued at nearly $7,000.

PARK COUNTY.

Livingston, the county seat of this county, produces about 500,000 bricks per year. The bricks are of a fairly good quality, and are used entirely for local building.

CHOTEAU COUNTY.

Chinook and Havre in this county each have a brick yard. The brick at Havre is not good owing to the amount of lime pebbles in the mud. When the bricks were burned the dehydration of the lime pebbles entirely disfigure the bricks near Havre, however, where a fairly good brick clay is found. About 500,000 to 700,000 common building bricks are produced in this county annually.

POWELL COUNTY.

This county had a fine plant near Blossberg, which was recently transferred to Helena. Some very good bricks are made here, most of them being shipped to Helena, and some west. The clay is a good variety of pottery clay and plenty of it. Several thousand bricks are made each year and a ready market is always found. Large deposits of fire clay are also found around Blossberg.

BEAVERHEAD COUNTY.

Dillon, the county seat of this county, has two brick yards. The bricks that are burned here at present are not of the best quality, but some fairly good bricks in the past have been made, and many of the buildings of Dillon are built from them. They are light salmon color and quite hard. One of the kilns is located just at the edge of town, while the other is about a mile distant. The clay is nothing but alluvial, but there is plenty of it.

CARBON COUNTY.

This county turns out about 300,000 bricks per year. They are made and used at Red Lodge, the county seat. Considerable fire clay is also found near Red Lodge, but it is believed to contain too much iron pyrites to be of commercial value.

DAWSON COUNTY.

The clays of this county belongs to the alluvial type, and are good only for ordinary building bricks. Glendive, the county seat, has two kilns, which turn out about 800,000 bricks annually. These are used entirely for local building purposes. They are valued at nearly $6,000, and the labor to produce them amounts to about $3,500 per year.

GRANITE COUNTY.

One kiln is found in this county, and that is at Philipsburg, the county seat. Many calcareous clays have been sent in, and also several specimens of "Mineral Paint," a clay highly colored with iron oxide. The yard at Philipsburg claims to have a clay deposit 12 feet thick.

FERGUS COUNTY.

This county has one brick yard, located at Lewistown, the county seat. The bricks are made from the ordinary valley wash clay. Good fire clay is found here directly beneath the coal veins.

There are many other deposits of clay in Montana and several more minor plants using these deposits. Enough has been said, however, to show the extensive beds within the state, and some of the uses to which these are put.

In conclusion it may be said there are about 30 clay plants now in operation in the State, with nearly $400,000 invested in the business. These plants turn out clay products valued at more than $350,000 per year, employ something like 400 men, and pay them wages in all amounting to over $200,000. This is not a large figure, but enough to be of some importance, and all indications point to a bright future.

Barytes

The barytes found in the State is from several localities. The massive is principally from the Ruby Mountains, Madison County, and from near Missoula, Missoula County. The nodular is found at the head of Cabin Creek, Custer County, and the crystals are found on Cedar Creek, Dawson County. The deposit near Missoula is the only one in Montana, so far as the writer knows, that is large enough to be of commercial value. It is located about two miles southwest of the city of Missoula, on the west bank of Pattee Creek, north of Mount Mitten, and is one of the best and purest deposits in the Northwest. The vein is somewhat broken at the surface; some places, however, are from two to three feet thick and very pure. The vein has a strike nearly east and west, and dips northeast about 70 degrees. The outcrop is well defined for several hundred feet. With more development work it may turn out to be much larger than at present supposed.

This mineral is also known as heavy spar, and is composed of ($BaSO_4$) barium sulphate. It has a specific gravity of about 4.5 and a hardness between 2.6 to 3.4.

The nodular barytes is from the head of Cabin Creek, 23 miles south and east of Ekalaka, Custer County, and is in the Fox Hills formation. The shape of the nodular barytes is spheroidal, with a whitish blue color and a specific gravity of 4.7 nearly. Some of the nodules are from 5 to 10 centimeters in diameter through the long axis, and from 3 to 7 centimeters through the short axis. The nodules are quite abundant at the head of Cabin Creek, and always occur with selenite in clay. One stratum was very productive of the nodules, and was traced for over a half mile.

Several chemical analyses were made by Mr. Martin Jones, B. S., now of the Philippine Islands, with the following results:

BaO	65.60 per cent.
SO_3	34.32 per cent.
Total	99.92 per cent.

The crystals of barytes were found about 25 miles from the mouth of Cedar Creek, Dawson County, also in the Fox Hills formation. Only one large piece was found, as perfect crystals. This piece is a large radiating rodule. The crystals very much resemble the barytes of South Dakota. They have a wine color, and belong to the orthorhombic system. Their length is from 6 to 8 centimeters and about 1 centimeter thick.

Barytes is used as a white pigment in paints, especially when mixed with white lead, also in the manufacturing of "paper, cloth, rubber, barium salts and as an adulterant. The principal steps in the preparation of barytes for market are hand cobbing, sorting, crushing, washing or jigging, bleaching, grinding and pulverizing. The price per ton as taken from the Mining World of March 14, 1908, is as follows: Barytes, f. o. b. New York, domestic, prime, short ton, $17 to $19. Off color, $12.50 to $16 per short ton."

Graphite

The graphite of Montana is found, as far as the writer now knows, in commercial quantities, in but one place in the State. There have been reports sent in from several places stating that commercial graphite was found at certain localities, but no specimens have ever reached the University.

The commercial graphite found in Montana is located 11 miles southeast of Dillon in the Van Camp Canyon. The wagon road leading to the deposit is a rather rough one, especially from the mouth of the canyon to the mine. The road from the mine to Dillon is all down grade, and large loads could be hauled to town, providing a little work was done on the roads from the mouth of the canyon up.

The graphite is found in a quartzite schist, and probably belongs to the pre-Cambrian period. The vein is made up of stringers of graphite and can be traced by its outcrop north and south several miles. The mine developed most is on the eastern slope of the Black Tail range of mountains. Van Camp Creek has its source in the little valley near by. The graphite is quite pure and as good a quality as any mined in New York. As yet, not enough development work has been done to determine the value of the deposit. Several hundred pounds have been mined and most of it stored in barrels and placed near the mine or in a cabin close by.

The presence of graphite at this place has been known for sime time, and once considerable prospecting work was done. Of late, however, little or no attention has been paid to it.

In order to determine the value of the Van Camp Canyon deposit more prospecting and more developing work would have to be done.

Uses—Graphite when mixed with clay is used in making the lead for lead pencils; when mixed with clay and sand it is used in the manufacture of crucibles. It is also used for "stove polish, foundry facings, paints, lubricants, glazing, electrotyping," etc.

The price of graphite per ton, as quoted in the Mining World for March 14, 1908, is as follows: Pulverized, domestic, per short ton, $45.00 to $150.00 f. o. b. New York.

CONTENTS

Acknowledgments ---- 2
Amalgamated Copper Company, Belt ---- 17
Analysis of Gypsum ---- 32
Analysis of Gypsum from Armington ---- 39
Analysis of Barytes ---- 65
Barytes ---- 65
Bear Creek Coal Area ---- 7
Beaverhead County, Sandstone in ---- 44
Beaverhead County, Clay in ---- 64
Bridger Coal Field ---- 9
Bull Mountain Coal Field ---- 17
Butte Sewer Pipe and Tile Company ---- 57
Carbon County, Clay in ---- 64
Carbon County, Coal Deposits in ---- 43
Carbon County, Sandstone in ---- 44
Cascade County, Clay in ---- 60
Cascade County, Coal in ---- 15
Cascade County, Sandstone in ---- 45
Choteau County, Clay in ---- 63
Choteau County, Sandstone in ---- 45
Clay Industry ---- 53
Coal and Lignite Deposits ---- 3
Contents ---- 68
Cottonwood Coal Company, Stockett ---- 15
Cross Section of Gypsum Beds near Crocket ---- 37
Custer County, Sandstone in ---- 45
Dawson County, Clay in ---- 64
Deer Lodge County, Clay in ---- 61
Fergus County, Clay in ---- 64
Fergus County, Coal in ---- 19
Fergus County, Sandstone in ---- 46
Figures ---- I
Flathead County, Clay in ---- 61
Gallatin County, Clay in ---- 63
Gallatin County, Coal in ---- 14
Geological Formation of Gypsum Deposits ---- 38
Granite County, Clay in ---- 64
Granite ---- 49
Graphite ---- 66
Gypsum Deposits ---- 31
Gypsum, North Field ---- 32
Gypsum Mill, North Field ---- 33
Gypsum Beds, North Field ---- 34
Introduction ---- 1
Jefferson County, Granite in ---- 49
Lewis and Clark County, Clay in ---- 54
Lewis and Clark County, Granite in ---- 49
Lime ---- 40
Limestone ---- 48
List of Coal Operating Properties ---- 27
Longitudinal Section of Gypsum Deposit, near Crocket ---- 36

Longitudinal Section of Gypsum Deposit near Bowler 36
Machinery for Plaster of Paris 38
Middle Gypsum Field 34
Mining Rates 24
Missoula County, Clay in 59
Montana Building Stone 43
Montana Coal and Coke Company 12
Northwestern Improvement Company, Mountainside 14
Northwestern Improvement Company, Red Lodge 3
Ourput of Coal and Coke, 1906 22
Output of Coal and Coke, 1907 26
Park County, Clay in 63
Park County, Coal in 12
Phyllite or Siliceous State 51
Plates I
Powell County, Clay in 63
Production of Coal by Counties, 1907 30
Quartzite 50
Ravalli County, Clay in 62
Rosebud County, Clay in 62
Sanders County, Clay in 61
Sandstone 43
Scale of Wages in 1906 20
Scale of Wages in 1907 23
Silver Bow County, Granite in 49
Silver Bow County, Clay in 57
South Gypsum Field 35
Sweet Grass County, Sandstone in 46
Trail Creek Coal Field 11
Valley County, Clay in 63
Volcanic Ash 51
Western Clay Manufacturing Company 54
Yellowstone County, Clay in 63
Yellowstone County, Coal in 17
Yellowstone County, Sandstone in 46